

**ALBERTA-PACIFIC FOREST INDUSTRIES INC.
ENVIRONMENTAL IMPACT ASSESSMENT**

**BLEACHED KRAFT PULP MILL
MAIN REPORT**

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53787



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May 08, 1989

Honourable Ralph P. Klein
Minister of Environment
Room 130, Legislature Bldg.
Edmonton, Alberta
T5K 2B6

LETTER OF TRANSMITTAL

Dear Mr. Minister:

**Reference: Bleach Kraft Pulp Mill
 Environmental Impact Assessment**

Alberta-Pacific Forest Industries Inc. is pleased to submit the detailed Environmental Impact Assessment (EIA) for our proposed bleach kraft pulp mill. This document, which was prepared for us by Beak Associates Consulting Ltd., is in three volumes consisting of an Executive Summary, a Main Technical Report and a Public Consultation Report.

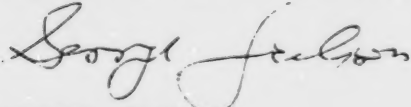
Alberta-Pacific, in designing this project, has accepted fully the Alberta Government principle of Best Achievable Technology. The mill process control technology includes the incorporation of extended delignification (modified continuous cooking), oxygen delignification, high (70%) chlorine dioxide substitution and a multi-stage pre-bleach washing method.

It is our intention to make this report widely available at this time to the general public as well as to your department. Once the public has had an adequate period to review the documents, we plan to hold a number of regional public meetings in order to receive and consider any additional comments and to respond to any concerns not voiced in our initial round of discussions with the public.

We look forward to your consideration of this document and to working with Alberta Environment and the public to ensure that this project results in the maximum possible benefit to Albertans.

Yours truly,

ALBERTA-PACIFIC FOREST INDUSTRIES INC.

A handwritten signature in cursive script, appearing to read "George Jackson".

George Jackson
Executive Vice-President

GJ/al

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1.0 INTRODUCTION

1.1 PROJECT BACKGROUND

On July 29, 1988, Crestbrook Forest Industries Inc. submitted a preliminary application to the Government of the Province of Alberta for utilization of wood resources in east central Alberta. This application to build a bleached kraft pulp mill was based on preliminary resource, environmental and market studies, a pre-feasibility study, and ongoing feasibility and pre-engineering studies. Figure 1.1 shows the general location of the proposed mill site and Figure 1.2 is a pictorial representation of the preliminary mill layout.

Crestbrook's application was supported during the remainder of 1988 and into 1989 by project definition phase engineering and detailed environmental impact assessment work in the context of extensive discussions with the Alberta Government. Additional work and discussions carried out were as follows:

- Forestry audit and analysis by Timberline Forest Inventory Consultants and Pearson Forestry Consulting Ltd.
- Site selection by Stanley Associates Engineering Ltd.
- Geotechnical and foundation investigation by Klohn Leonoff Ltd.
- Definition of design and capital cost requirements for site development, water supply and treatment, effluent supply and treatment and utility, rail and road connections by Stanley Associates.

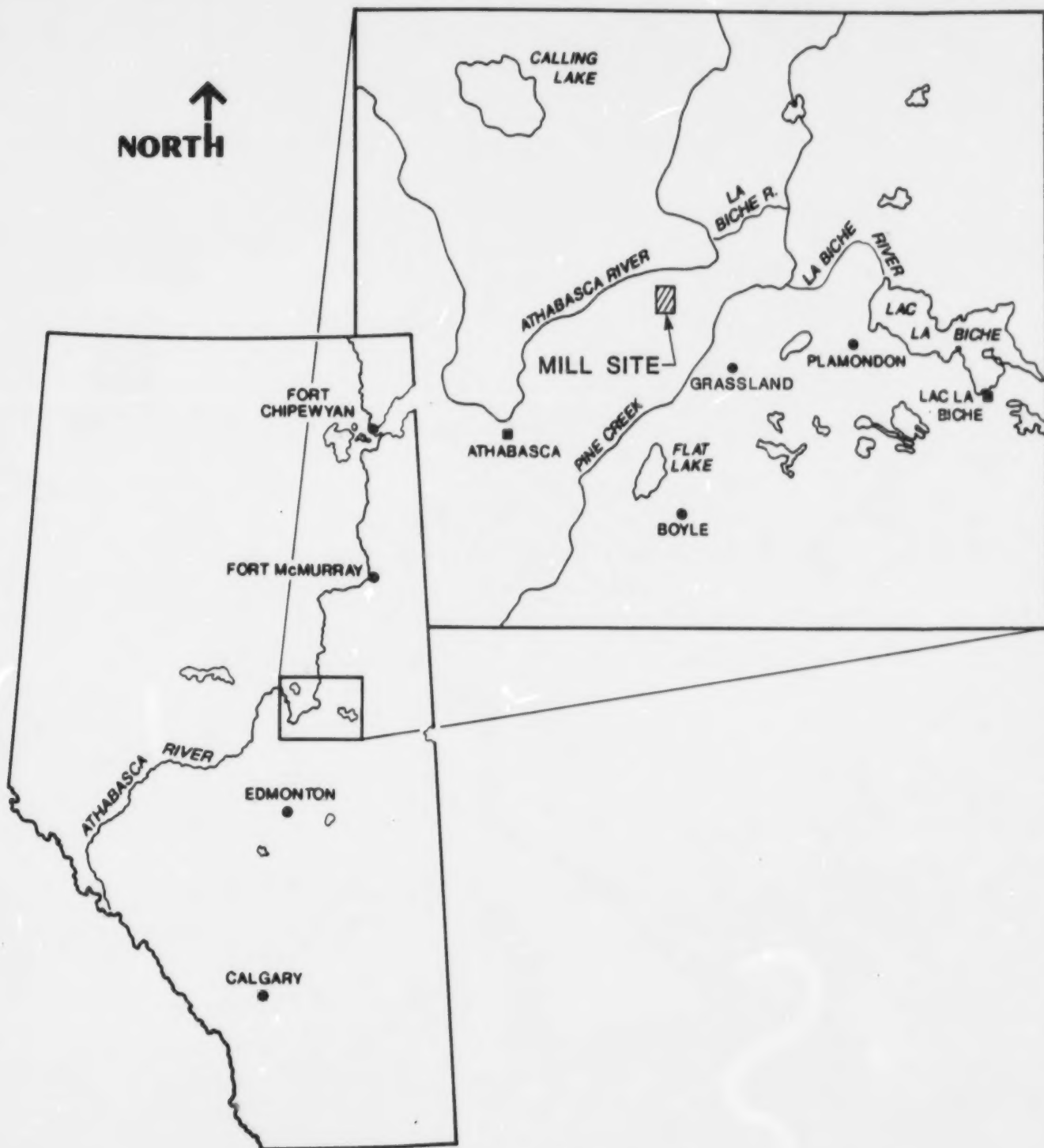


Figure 1.1

SITE LOCATION OVERVIEW

- Definition of basic mill process, layout and operating concept; overall and major area design criteria and estimated capital costs of construction; and project implementation and scheduling by H.A. Simons Ltd.
- Initial Environmental Evaluation, including dissolved oxygen and atmospheric emission modelling, by Stanley Associates.
- Economic Impact Assessment by Price Waterhouse.
- Pulping and Bleaching Trials by Econotech Services Ltd.
- Market Review by Resource Information Services Inc.
- Discussions with local trucking, rail and airline firms on road and rail connections and other requirements for the transportation of construction materials and finished products.
- Discussions with TransAlta Utilities regarding provision of an electrical tie line and purchase by the mill of power for construction and operations.
- Discussions with Nova Corporation regarding purchase of natural gas.
- Securing of options on property for the related mill site, including a buffer zone, through Canadian Landmasters Resource Services Ltd.

1.2 PROJECT PROPONENT

Alberta-Pacific Forest Industries Inc. is a wholly-owned subsidiary of Crestbrook Forest Industries Ltd. established to implement the Athabasca pulp mill project. Crestbrook Forest Industries Ltd. is an



Alberta-Pacific Forest Industries Inc.

Figure 1.2 PRELIMINARY MILL LAYOUT

integrated forest products company that produces bleached kraft pulp, lumber and plywood products for the domestic and export markets. The majority of Crestbrook's operations are located in the East Kootenay region of British Columbia. Crestbrook also operates a plywood plant in Fort Macleod, Alberta.

Crestbrook Forest Industries Ltd. is a public company with stocks listed on the Toronto and Vancouver Stock Exchanges. The two major shareholders of Crestbrook are Honshu Paper Company and Mitsubishi Corporation, both of Japan. These two companies each hold approximately 32 percent of Crestbrook's shares.

Honshu is the second largest papermaker in Japan and has extensive experience with the production of high quality, value added printing papers. Mitsubishi is one of Japan's leading trading houses and is able to provide a well developed network of sales outlets covering five continents through which pulp, paper and wood products can be sold.

Crestbrook currently has the following operations:

- three high utilization sawmills located at Cranbrook, Canal Flats and Elko, B.C., with a total annual production of 470 million board feet of lumber;
- a veneer plant located at Creston, B.C., annually producing 3500 M 3/8" basis plywood veneer;
- a plywood plant located at Fort Macleod, Alberta, annually producing 55,000 M 3/8" basis of softwood and hardwood plywood;
- a bleached kraft pulp mill at Skookumchuck, B.C., producing 185,000 ADt/year market pulp; and

- six woodlands operations located throughout the areas of resource harvesting.

Crestbrook's total sales in 1987 were approximately \$240 million.

1.3 ENVIRONMENTAL IMPACT PROCESS

As a first step to gain approval for the pulp mill project, Crestbrook Forest Industries has commissioned this environmental impact assessment report. In compliance with the Alberta Environmental Impact Assessment Guidelines, the report fulfills the following main objectives:

- to describe the proposed mill facilities, infrastructure and manufacturing process, and the environmental management systems to be employed;
- to identify the main environmental, community and economic impacts of construction and operation of the proposed mill;
- to identify the environmental, community and economic issues that are of concern to municipal governments and provincial government agencies and departments;
- to identify by means of a public consultation program the issues of concern to members of affected communities; and
- to describe the measures to be adopted to 1) address the concerns of the public and government departments, 2) minimize or eliminate possible negative impacts of the project, and 3) enhance favourable effects of the project.

These objectives are achieved by an interactive process involving public and government review of draft stages of the EIA document.

During the preparation of the EIA, Alberta-Pacific has attempted to describe the basic project components to the public through informal meetings and a series of more formal open houses. In turn, these meetings have been used to identify issues of public concern; wherever possible these have been described and addressed in the EIA. As issues were identified, programs have subsequently been developed to reduce or eliminate associated impacts and those mitigative measures are also described in this document.

With the completion of the EIA, it is now Alberta-Pacific's intention to distribute the report to as broad a segment of the general public as practical for review, as well as to Alberta Environment and the other appropriate government agencies. A series of public meetings will then be held in the region to allow the public to ask questions and receive answers from Alberta-Pacific on the content of the EIA document. When released, the document will receive wide distribution through Alberta-Pacific's eleven liaison offices. The public meetings will likely begin about three weeks from the release date of the EIA document.

Major emphasis in this report was placed on the key issues of 1) effluent quality and the impacts of the effluent on the Athabasca River, 2) air quality, and 3) the socio-economic assessment and public consultation program. The EIA document is designed to have an easily understood main report followed by technical appendices containing more detailed information. Some detailed information has been brought forward to the main report to assist in the evaluation of key impacts. Environmental impacts associated with forestry operations are outside the scope of this assessment and will be addressed in separate reports filed with the Alberta Forest Service.

The environmental impact assessment report was prepared by Beak Associates Consulting Ltd.

1.4 REGULATORY REQUIREMENTS

The first regulatory requirement for approval of the pulp mill project is acceptance of the environmental impact assessment report by Alberta Environment. A key component of approval by Alberta Environment will be the acceptance that public concerns have been adequately identified and addressed. Subsequent permitting requirements at the federal, provincial and municipal levels of government must then be met.

1.4.1 Federal Requirements

The Athabasca River is covered by the Canada Navigable Waters Protection Act. Application will be made to the Canadian Coast Guard, administrator of the Act, for permission to install a water intake and effluent diffuser in the river.

All other federal requirements, including those under the Canadian Environment Protection Act of 1989, will be met.

1.4.2 Provincial Requirements

A forest management agreement (FMA) will be negotiated with the Alberta Forest Service. The FMA will allocate specific forest resources to the project and cover all aspects of the harvesting and management of these resources, including environmental and land use impacts. Other provincial regulatory requirements fall under the Water Resources Act, the Clean Air Act, and the Clean Water Act, all administered by Alberta Environment; and the Wilderness Areas, Ecological Reserves and Natural Areas Act, administered by Alberta Forestry Lands and Wildlife.

- Water Resources Act

Application will be made under this act for the right to utilize water from the Athabasca River and to install a water intake and an effluent diffuser.

- Clean Air Act

The Clean Air Act governs maximum levels of atmospheric emissions that are allowed. A separate Permit to Construct and Licence to Operate must be obtained under the Act for the construction and operation phases of the project.

- Clean Water Act

Alberta-Pacific must secure a Permit to Construct and a Licence to Operate the mill under the Clean Water Act, which governs maximum allowable effluent discharges. On-site landfill operations will be subject to the Guidelines for Industrial Landfills, and will require separate permits under the Act.

- Wilderness Areas, Ecological Reserves and Natural Areas Act

A permit is required under this Act to construct and operate any facility within the Pine Sands Natural Area. The facilities involved are the water intake and the northern portions of the raw water pipeline, warm water return pipeline and associated access road.

1.4.3 Municipal Requirements

The proposed mill site is in the County of Athabasca No. 12 and lies within an area designated as an Agricultural Use District under the County's Land Use Bylaw No. 10-1987. No rezoning under the by-law is required, as the pulp mill would be a discretionary use (natural resource extraction) within this land use zone. However, the company will negotiate and enter into a Development Agreement with the County of Athabasca covering such local issues as alterations in the road pattern.

1.5 STUDY REGIONS

Study regions have been defined separately as appropriate for each sphere of potential impacts.

Aquatic impacts are examined in the Athabasca River as far downstream as the vicinity of Fort McMurray, approximately 350 km downstream of the mill.

The primary impact region for atmospheric impacts is within 10 km of the mill site, where the maximum effects will occur.

The primary impact region for terrestrial impacts is within 8 km of the mill site. This area includes the main mill site and the water supply and effluent disposal facilities. Road and rail access routes and an electrical tie line are covered by a secondary impact region extending a few tens of kilometres.

Socio-economic impacts are assessed in a region comprising the County of Athabasca and portions of Improvement Districts 17 and 18. Located within this broadly defined region are the urban communities of Athabasca, Boyle, Grassland, Lac la Biche and Plamondon, the Indian Reserves of Calling Lake, Beaver Lake, and Heart Lake, and the Metis Settlement of Beaver River. The population of this region is estimated to be 15,000 people.

The public participation program includes the socio-economic impact study region as well as downstream communities on the Athabasca River and additional communities within the Green Zone of the Forest Management Agreement area (Wabasca-Demerais and Peerless Lake).

1.6 GLOSSARY

The following list provides explanations for technical terms and abbreviations as they are used in this report.

Activated Sludge: a high-rate aerobic effluent treatment system that uses recycled biological sludge.

Acute: with reference to toxicity, happening quickly, usually within 4 to 7 days for fish. An acute effect can be lethal or non-lethal.

Absorbable Organic Halides (AOX): a measure of the concentration of organically bound halogens (principally chlorine).

Absorption: the penetration of substances into the bulk of a solid or liquid.

Adsorption: the taking up of a substance at the surface of another substance.

ADt/a, ADt/d: air dried tonnes per annum, day; standard units of pulp production.

Aerated Stabilization Basin (ASB): a low-rate aerobic biological effluent treatment system which uses a long retention time to reduce BOD and effluent toxicity.

Aerobic: occurring in the presence of oxygen.

Air dry (pulp): 90% dry fibre and 10% moisture.

Alum: a chemical used in water treatment to remove solids by causing them to aggregate and thereby settle to the bottom.

Anaerobic: occurring in the absence of oxygen.

Aquifer: a permeable stratigraphic unit that can hold and transmit large quantities of water.

Aquitard: a relatively impermeable stratigraphic unit that cannot hold or transmit significant quantities of water.

Benthic monitoring: monitoring of the population structure of organisms such as aquatic insects that live on the river bottom, in this case in order to allow for detection of subtle effects of mill effluent.

Bioaccumulation (bioconcentration, biomagnification): the storage by an organism within its body of a higher concentration of a substance than is found in its environment.

Bioassay: as used here, an acute lethality toxicity test using fish (normally rainbow trout).

Biochemical oxygen demand (BOD): a measure of the amount of oxygen that would be consumed by aquatic organisms in breaking down an organic substance; also referred to as biological oxygen demand; BOD₅ is the five-day BOD.

Black liquor: a liquid in the kraft process, composed of spent pulping chemicals and wood residues. Weak black liquor refers to concentrations under 20% solids, strong black liquor to concentrations over 50% solids.

Bleach plant: the portion of the mill in which chlorine and other chemicals are used in sequence to purify and bleach brownstock, principally by removal of residual lignin.

Brightness: a measure of the whiteness of paper as compared to a standard.

Brownstock: kraft slush pulp prior to bleaching.

Carcinogenic: capable of causing cancer.

Caustic: commonly used name for sodium hydroxide.

Cellulose: the fibrous component of wood from which pulp is made.

Chemical oxygen demand (COD): a measure of the amount of oxygen required for non-biological chemical reactions in water.

Chemical recovery: the sequence of processes through which cooking chemicals are recycled.

Chlorinated organic compounds: organic compounds to which at least one atom of chlorine is chemically bound; also known as organochlorines.

Chlorine multiple: in bleaching, the ratio of the chlorine charge per unit of pulp to the Kappa number.

Chronic (non-lethal) toxicity: a long lasting or continued toxic effect other than death, such as reduced reproduction or growth rates.

Clarifier: a settling basin providing for passive removal of solids from water.

Clearwell: a reservoir of treated water for use in the mill.

CNR: Canadian National Railway.

Cooking: the chemical pulping process in the digester where the fibre is separated from lignin by chemicals under pressure at elevated temperatures.

Cooking liquor: the chemical solution, mainly sodium hydroxide and sodium sulphide, used in cooking; prepared from white liquor by filtering out calcium carbonate.

Coniferous: trees that retain their leaves all year round; also known as softwood; in this area mainly spruce and jackpine.

Cyprinid fish species: carps and minnows.

CTMP: chemi-thermomechanical pulping.

d: day.

Deciduous: trees that lose their leaves each year; also known as hardwood; in this area mainly aspen poplar.

Defoamer: a substance used to suppress the formation of bubbles.

Diffuser: a structure used to discharge treated effluent through multiple ports, in order to promote rapid mixing with the receiving water.

Digester: the vessel in which wood chips are cooked.

Dispersion: mixing and dilution of gaseous emissions in the atmosphere or of liquid effluents in water.

Dissolved oxygen (DO): the amount of oxygen dissolved in water. DO is critical to aquatic life and is affected by BOD.

Effluent: treated liquid waste of the mill operation.

EIA: environmental impact assessment.

Electrostatic precipitation: a method of removing particulate matter from gaseous emissions using electrically charged plates.

Fibre line: the portion of the mill operations devoted to processing wood into fibre.

Forest Management Agreement (FMA): an agreement between the government and the company regarding timber harvesting access, rights and obligations in a given area; the term FMA is also sometimes used to refer to the area subject to the agreement.

Fourdrinier: the first machine in the pulp drying operation; uses a porous belt passing over rollers and areas of vacuum to dewater pulp-water slurry to the point that it can be formed into a sheet.

Green liquor: a liquid in the kraft process composed of the chemicals obtained from the recovery furnace. Primarily sodium sulphide and sodium carbonate in aqueous solutions.

Grits: in kraft mills, the inert lime rejected from the slaker in the recausticizing department.

h: hour.

ha: hectare (2.47 acres, approximately).

Half life: time required for the concentration of a substance to be reduced by half.

Hardwood: see deciduous.

Hog fuel: wood waste used in pulp and paper industry boilers, mainly bark but may also include sawdust, reject chips, sticks, branches and other saw mill and wood harvesting wastes; sometimes called waste wood fuel (WWF).

HVLC: high volume, low concentration.

Hydrostratigraphic unit: one or more contiguous geological strata that can be defined as a single unit for hydrological purposes.

IEE: Initial Environmental Evaluation.

Impact: effect.

Infiltration: passage of surface water into the ground.

Intermittent stream (or watercourse): a stream that flows only part of the year.

Kappa number: a measure of lignin in pulp.

kg, kg/d: kilogram, kilograms per day.

km, km²: kilometre, square kilometre.

kV: kilovolt.

Knotter: a type of screening equipment used to separate knots and other large, oversized and unwanted material from wood pulp.

Kraft: chemical pulping process using a sodium hydroxide/sodium sulphide cooking liquor.

Lignin: a glue like resin that binds wood fibres together.

Lime kiln: furnace used to prepare lime (calcium oxide) from calcium carbonate.

Lime rock: limestone (a form of calcium carbonate).

LVHC: low volume, high concentration.

m: metre

m³/s: cubic metres per second; a standard unit of flow measurement.

Medium consistency chlorination: the use of a thicker than conventional pulp-water slurry in bleaching in order to improve bleaching efficiency.

mm: millimetre

mg/L: milligrams of a substance per litre of solution; roughly speaking parts per million. This is the common unit for assessing water quality.

MPa: megapascals, a unit of pressure.

MW: megawatt.

Mitigation measure: a measure that lessens or offsets an effect or impact.

Modified continuous cooking: a variation of the kraft cooking process that allows more lignin to be removed without sacrificing pulp quality.

Multiple chemical addition: sequential addition of small amounts of bleaching chemicals rather than a single, larger application in order to improve bleaching efficiency.

Order of magnitude: factor of 10.

Organochlorine: an organic compound which includes chemically bound chlorine.

Particulates: solid particles small enough to be suspended in a column of air.

pH: a measure of the acidity or alkalinity of water or some other medium. pH 7 represents a neutral condition; values of pH below 7 represent acid conditions and values above 7 represent alkaline (basic) conditions.

Photolysis: the decomposition of a compound into simpler compounds by radiant energy.

Power boiler: the boiler in which mill wood wastes and other organic wastes are incinerated in order to generate steam power.

ppm, ppb, ppt: parts per million, billion, trillion; respectively equal to milligrams per litre (mg/L, micrograms per litre (ug/L) and nanograms per litre (ng/L).

Precursor compound: a substance necessary to the chemical formation of another substance; e.g. dioxins are precursors of chlorinated dioxins.

Pretreatment: initial treatment processes before an effluent reaches primary treatment. The processes are designed to remove grit, coarse material and debris, to neutralize acid or alkaline wastes, and to equalize the effluent characteristics and flows by mixing the collected

effluent streams and directing occasional large flows or concentrated streams which are a normal part of pulp mill operations to spill tanks or basins.

Primary treatment: the first step of effluent treatment, in which suspended solids are removed.

Recausticizing: the stage in the chemical recovery cycle in which lime is added to green liquor in order to produce white liquor; sometimes called causticizing.

Recovery Furnace: unit used to burn recovered cooking liquor to produce steam and to reprocess cooking chemicals; commonly called the recovery boiler.

RTA: registered trapping area.

s: second.

Scrubber: a piece of equipment used to remove certain gases or solids from a gas stream utilising a spray of liquid, usually water or an aqueous solution of reactant.

Secondary treatment: a stage of waste treatment in which micro-organisms decompose organic constituents in the effluent.

Section: square mile.

7Q10: seven-day, moving average low flow with anticipated frequency of once in ten years.

7Q2: same as above, with anticipated frequency of once in two years.

Slaker: the vessel in which lime is added to green liquor in the chemical recovery cycle.

Softwood: see coniferous.

Stability (atmospheric): the tendency of the atmosphere to either enhance (instability) or damp out (stability) vertical motion, and hence to respectively speed up or retard the dispersion of air pollutants.

Substrate: the bottom material in a water body.

Sulphur deposition (sulphation): the amount of sulphur, expressed as sulphate, deposited on a surface from the atmosphere. Total sulphur deposition is the sum of wet ("acid rain") and dry deposition.

Suspended solids: solid materials that are suspended in water.

t: tonne (1000 kg).

Threshold odour number: a measure of the lowest concentration of a substance that gives off a detectable odour.

Threshold of detection: the concentration of a substance below which it cannot be detected.

Total dissolved solids (TDS): the concentration of solids dissolved in a water sample.

Total organic chlorine (TOCl): a measure of the amount of chlorine chemically bound to organic compounds.

Total suspended solids (TSS): a measure of the concentration of solids suspended in water.

Toxic: a substance or a concentration that is harmful to a living organism.

TRS: total reduced sulphur; malodorous sulphur compounds such as hydrogen sulphide, methyl mercaptan, dimethyl sulphide and dimethyl disulphide.

Volatilization: a process by which a substance becomes vapour.

White liquor: a liquid in the kraft process composed of the chemicals used in the digester to cook the wood chips; primarily sodium sulphide and sodium hydroxide in aqueous solution.

WMU: wildlife management unit.

2.0 PROJECT DESCRIPTION

2.1 PROJECT OVERVIEW

The pulp mill will produce bleached kraft market pulp from the presently under-utilized hardwood and softwood forest resources of northeastern Alberta. Public wood will provide 90% of the mill requirements and private wood will provide the remaining 10%.

The mill will incorporate state-of-the-art commercially proven technology. It will be built at world class size in order to attain the low unit cost of production required to enter the pulp market in a new location where wood costs are not the lowest.

The pulp mill will be designed to produce a nominal average of 1,500 air dried tonnes per day (ADt/d) of hardwood pulp during 260 days per year, yielding an annual production of 390,000 ADt. Softwood pulp production capacity will be 1,250 ADt/d for 85 days per year, yielding an annual production of 106,250 ADt. During the first four years of operation, the mill will run for an average of 288 days on hardwood and 57 days on softwood for an expected annual production of 432,000 ADt of hardwood pulp and 71,250 ADt of softwood pulp.

Hardwood furnish to the mill will be primarily aspen poplar, with up to 15% balsam poplar. Hardwood will be harvested and hauled to the mill in the form of tree length logs. Softwood fibre will be predominantly white spruce, although some jackpine, black spruce and balsam fir will also be included, and will comprise both roundwood and residual chips. Softwood chips will be hauled to the site by privately operated trucking companies. The overall mix will be 76% hardwoods and 24% softwoods.

The mill will be single line with the exception of some of the pulp washing equipment. This follows the modern trend for economical

capital and operating costs. The description of the mill can be considered typical, although new process techniques will be utilized to minimize environmental impact.

The pulping facility includes a continuous digester system, diffusion washer, pressure knotting and screening, washing, oxygen delignification, post-oxygen washing, bleaching, chemical unloading and preparation, pulp drying and finishing. The chemical recovery facility will include a multiple effect evaporator and concentrator train, a low odour recovery boiler with precipitators, a recausticizing plant, and a lime kiln, also with precipitator. Non-condensable malodorous gases will be collected and incinerated.

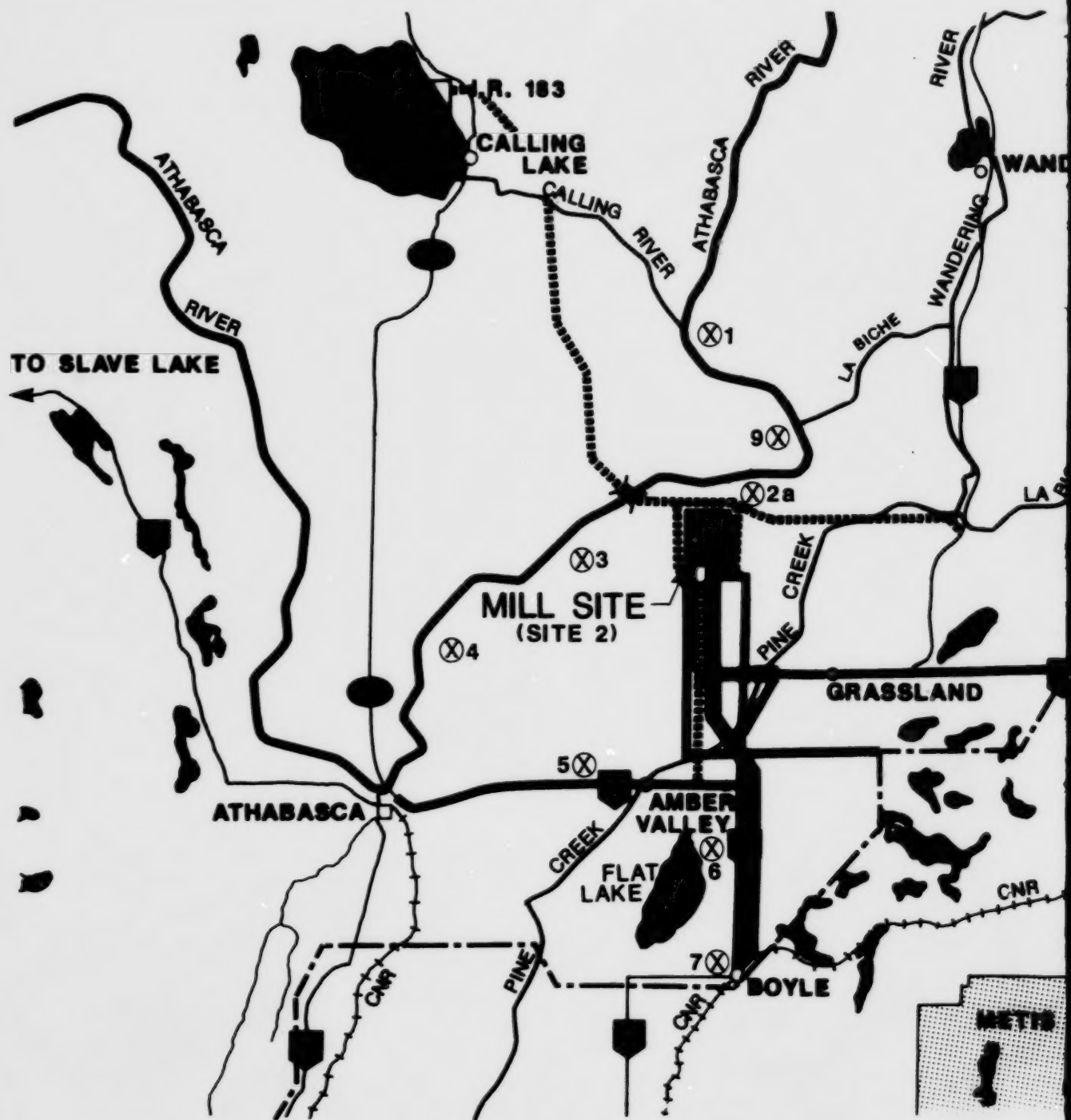
Process steam will come mainly from the chemical recovery boiler, with additional steam requirements being met by a power boiler burning primarily waste wood and other plant wastes. Electrical power requirements will come from two steam driven turbogenerators sized to optimize power generation. There will be a tie line to the local utility. Normally, the mill will purchase only a small fraction of its power needs; the tie line will be used primarily during shutdowns and cold start-ups.

Process water will come from the Athabasca River and process effluent will undergo primary and secondary treatment before discharge to the same river.

2.2 PROJECT SITE

2.2.1 Site Selection

The Athabasca - Lac La Biche region was selected as the general location for the project on the basis of the following considerations:



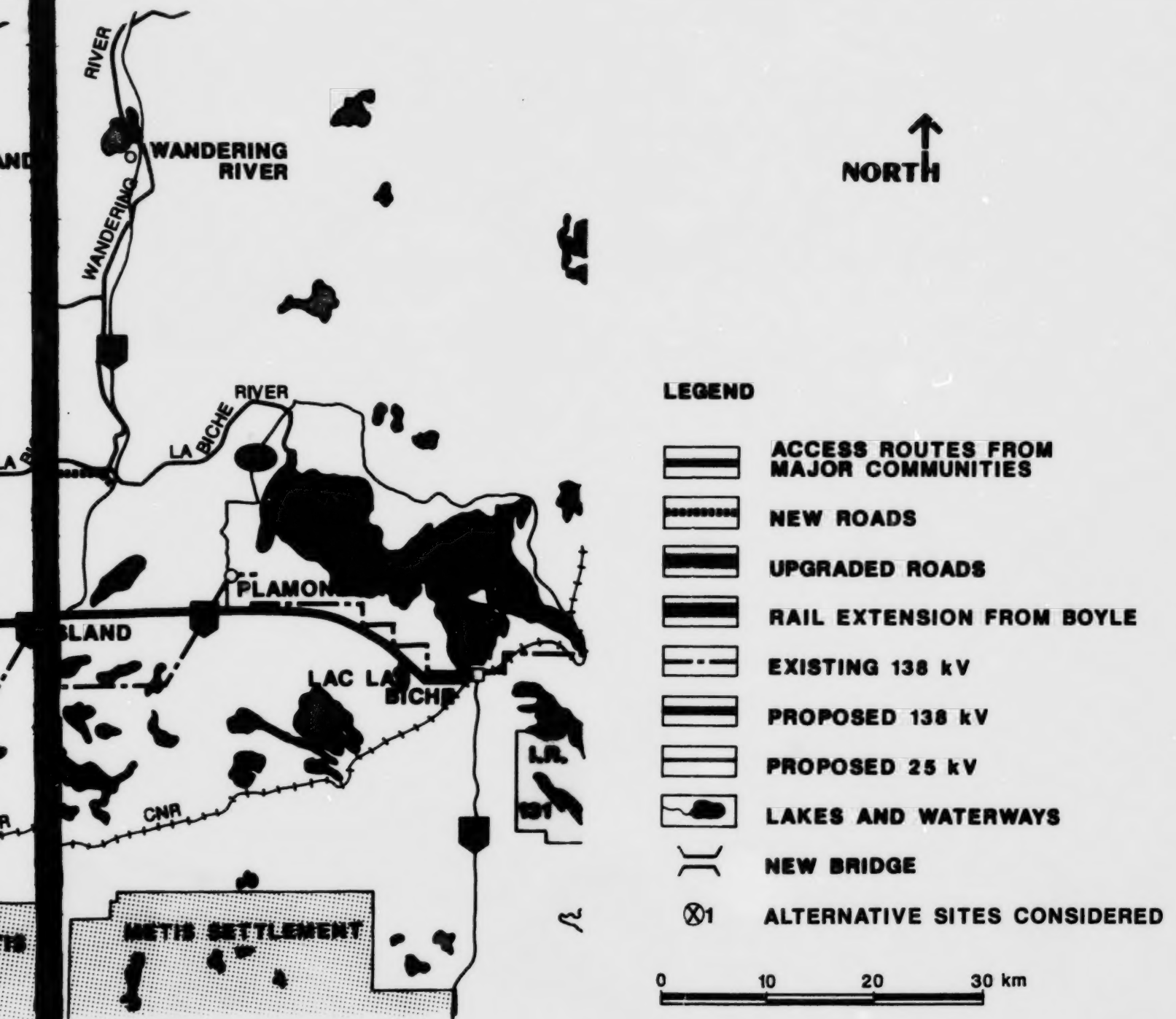


Figure 2.1

SITE LOCATION AND
INFRASTRUCTURE

- the region is located strategically on the Athabasca River with respect to the river's capacity to assimilate BOD loadings from existing and proposed upstream pulp mills and with respect to the major reaeration that occurs at Grand Rapids, between the region and Fort McMurray;
- the region is in need of additional economic development to strengthen and diversify the economy; and
- the region provides a convenient location for the pulp mill at the southern edge of the wood supply area in close proximity to existing urban, transportation and utility infrastructure.

Within the region, 9 locations potentially suitable for siting the pulp mill were selected and compared in terms of:

- availability of sufficient land for the proposed operation and potential future expansion;
- compatibility of the project with existing land use regulations and policies;
- suitability of terrain and foundation conditions;
- availability of granular materials;
- soil capability for agriculture;
- distance from sensitive wildlife habitat;
- presence of existing roads;
- feasibility and costs of developing the necessary road and rail access networks;

- feasibility and costs of water supply and effluent disposal systems;
- aquatic impacts, particularly on dissolved oxygen, of treated effluent discharge;
- distance from recreational lakes;
- availability of natural gas;
- proximity to the existing power grid; and
- proximity to and suitability of location with respect to urban centres.

The locations of the 9 sites considered are shown in Figure 2.1.

Considerable public concern was expressed regarding the site selection process used by Alberta-Pacific to ensure selection of the environmentally, socially and economically optimal mill location. A comparative analysis of the sites was carried out in a site selection study, attached as Appendix 5. The study indicated that Sites 2, 2a, 3 and 4 would be preferred over the others by a large margin from the cost point of view because:

- the costs of road and rail access development and operation at sites 1 and 9 would be very high, and
- the cost savings realized by being able to build a shorter rail connection to Sites 5, 6, 7 and 8 are far outweighed by the costs incurred in having a much greater distance from the Athabasca River over which it would be necessary to transport water into and effluent out of the site.

Additional disadvantages of the other sites were:

- undue proximity to urban centres (Sites 5, 6 and 7),
- proximity to important waterfowl habitat at Flat Lake (Sites 6 and 7), and
- remoteness (Site 1).

Sites 2 and 2a were preferred over Sites 3 and 4 because:

- they are more economical to develop;
- they have a more favourable location on the Athabasca River with respect to dissolved oxygen considerations;
- they are more centrally located between Athabasca and Lac La Biche; and
- Site 4 is considered to be too close to Athabasca.

Site 2a would be marginally more economical to develop than Site 2, but Site 2 was selected as the preferred location for the mill because:

- there is more room for development;
- foundation conditions are better;
- it is further from the Pine Sands Natural Area;
- it involves less disturbance of riverine habitat; and
- it is not located on class 3 agricultural soils.

The site selected is approximately 50 km downstream of the Town of Athabasca on high ground on the south side of the Athabasca River, in the County of Athabasca No. 12. Present land ownership is primarily private. Alberta-Pacific has obtained purchase options from owners of the land within the site boundaries and a surrounding buffer zone. The mill site comprises two sections (518 ha) of land, and the buffer zone is a half mile (800 m) wide. The purposes of the buffer zone are to:

- allow for future expansion, and
- prevent incompatible development from occurring.

A copy of the site selection study is attached as Appendix 5. The benefits of the selected site are listed in Section 3.1.

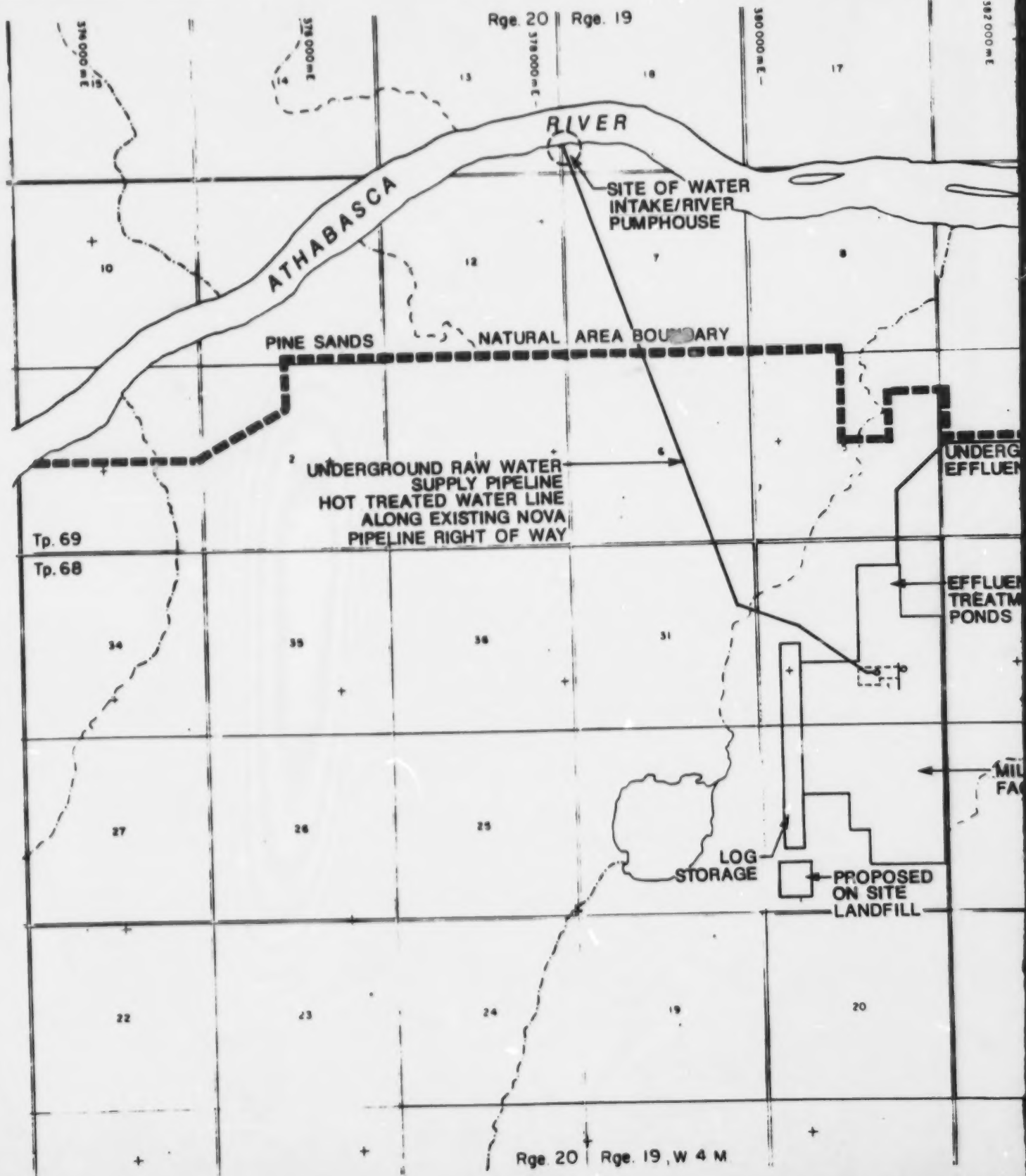
2.2.2 Site Access

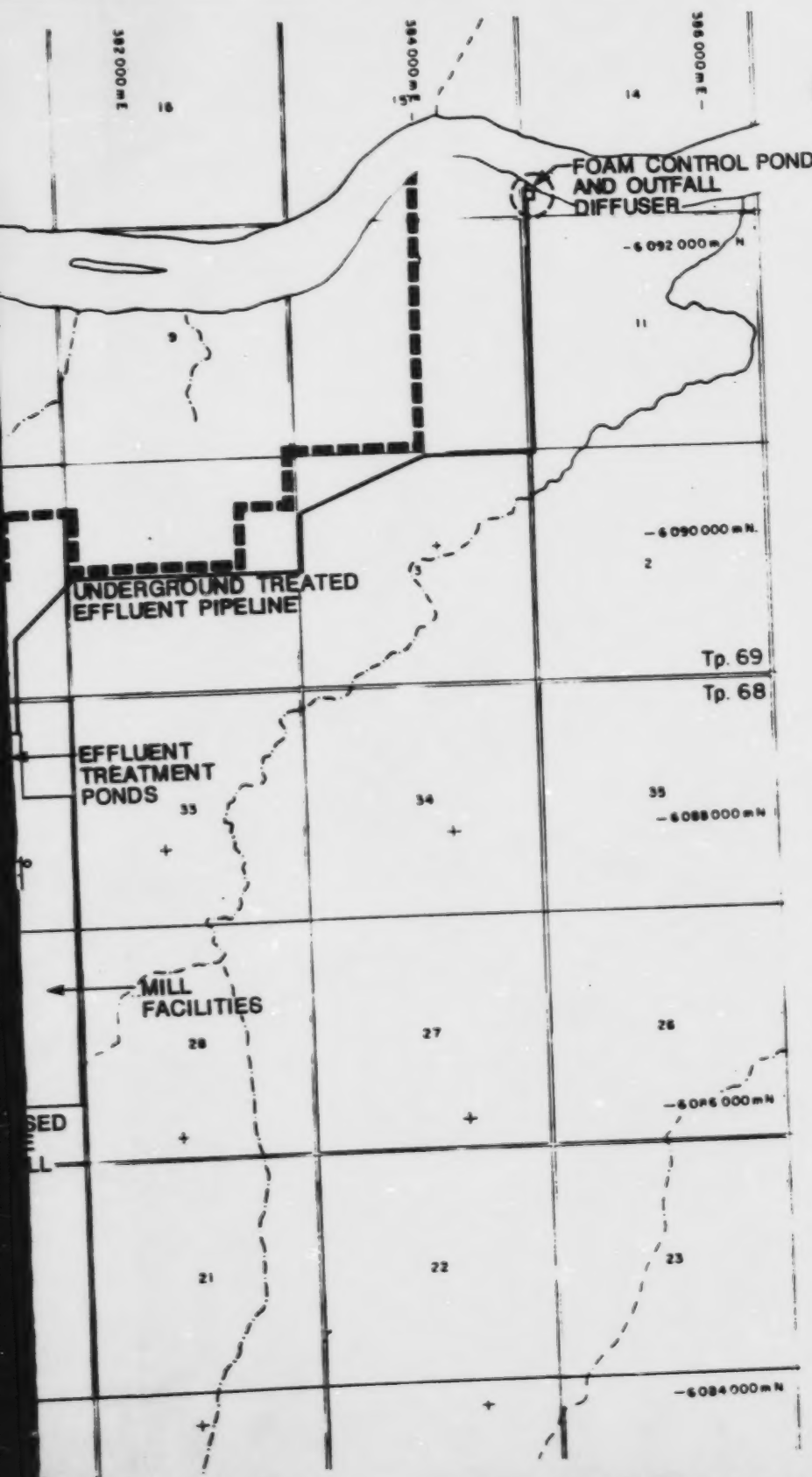
Figure 2.1 shows the overall location of the pulp mill site as well as the main transportation infrastructure associated with it.

Railway access to the site will be required for chemical delivery to the site and shipment of the product to market; it will be provided by the construction of a spur line leading north from the existing CNR line at Boyle. Road access to the site will be required for delivery of raw materials and commuting, and will be provided by a combination of new roads and upgraded roads connecting with Highways 55, 63 and 813. Details of the road and rail access are provided in Section 2.5.5.

2.2.3 Site Plan

The preliminary plan for the pulp mill site and infrastructures layout is shown in Figure 2.2, and the proposed mill site layout is shown in relation to ground contours in Figure 2.2a. Figure 1.2 shows a pictorial representation of the preliminary mill layout. The following dimensions provide an idea of scale;



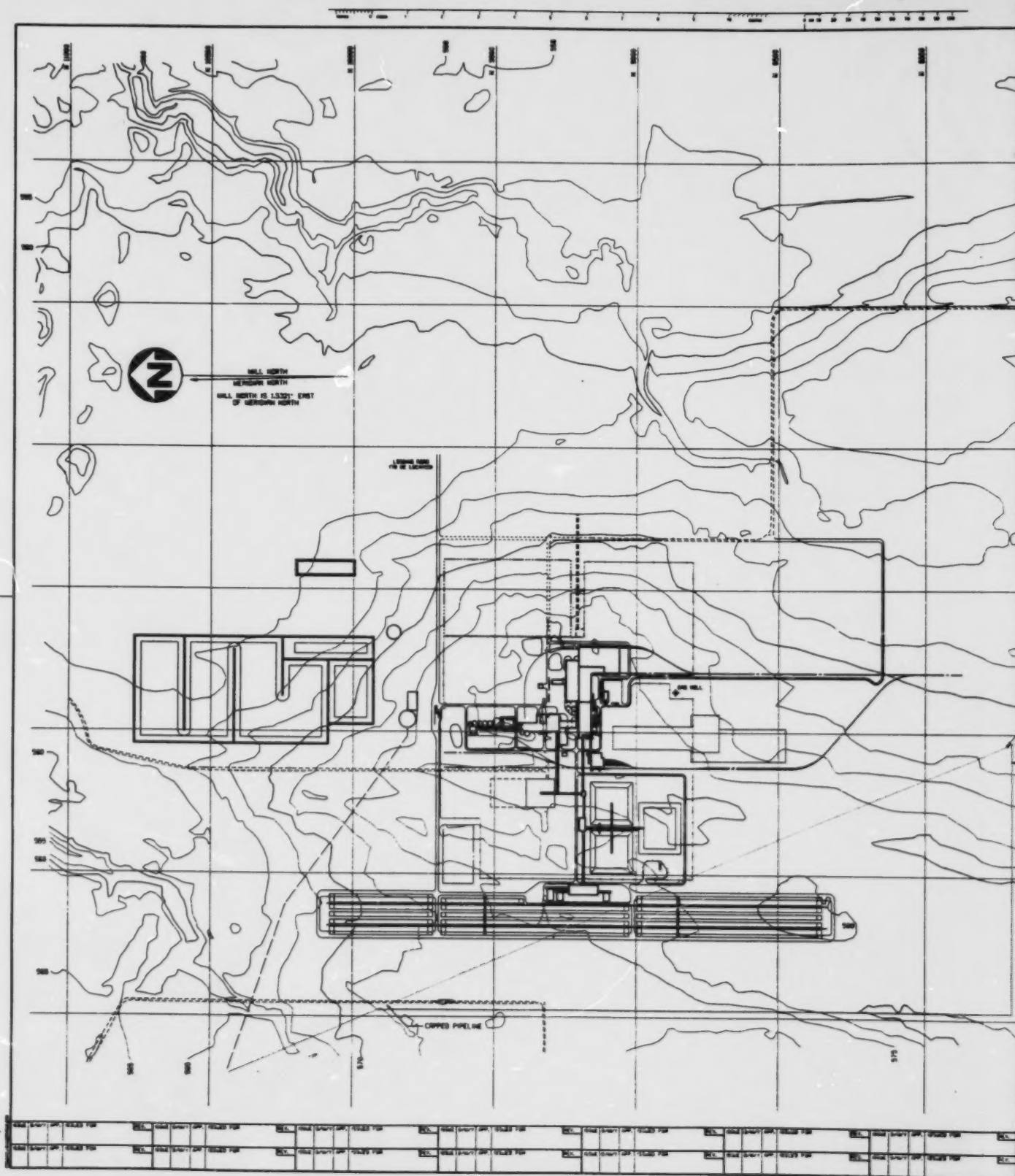


NORTH

SCALE

0 500 1000 2000m

Figure 2.2
MILL LAYOUT



- highest building 76 m
- highest stack 100 m
- mill length 500 m
- floor area 55,000 m²

Further consideration of the layout to optimize project efficiency is on-going.

2.3 WOOD SUPPLY

2.3.1 Wood Sources

The potential timber supply area comprises roughly 100,000 km², mainly north and east of the mill site. Approximately 73,000 km² of this area lies in the Green Zone and the remainder is in the White Zone (Figure 2.3). The Green Zone consists of mainly forested areas with significant potential for long-term forest development. The White Zone is a transition area between predominantly agricultural land in the south and the Green Zone in the north. It consists of a large amount of privately owned land (forested and agricultural), native settlement areas, and crown lands. Wood use will be both deciduous and coniferous, as shown in Table 2.1.

Table 2.1 Annual wood use.

	volume	% of total
Coniferous chips	299,000 m ³	12.4
Coniferous roundwood	274,000 m ³	11.4
Deciduous	1,833,000 m ³	76.2
Total	2,406,000 m³	100

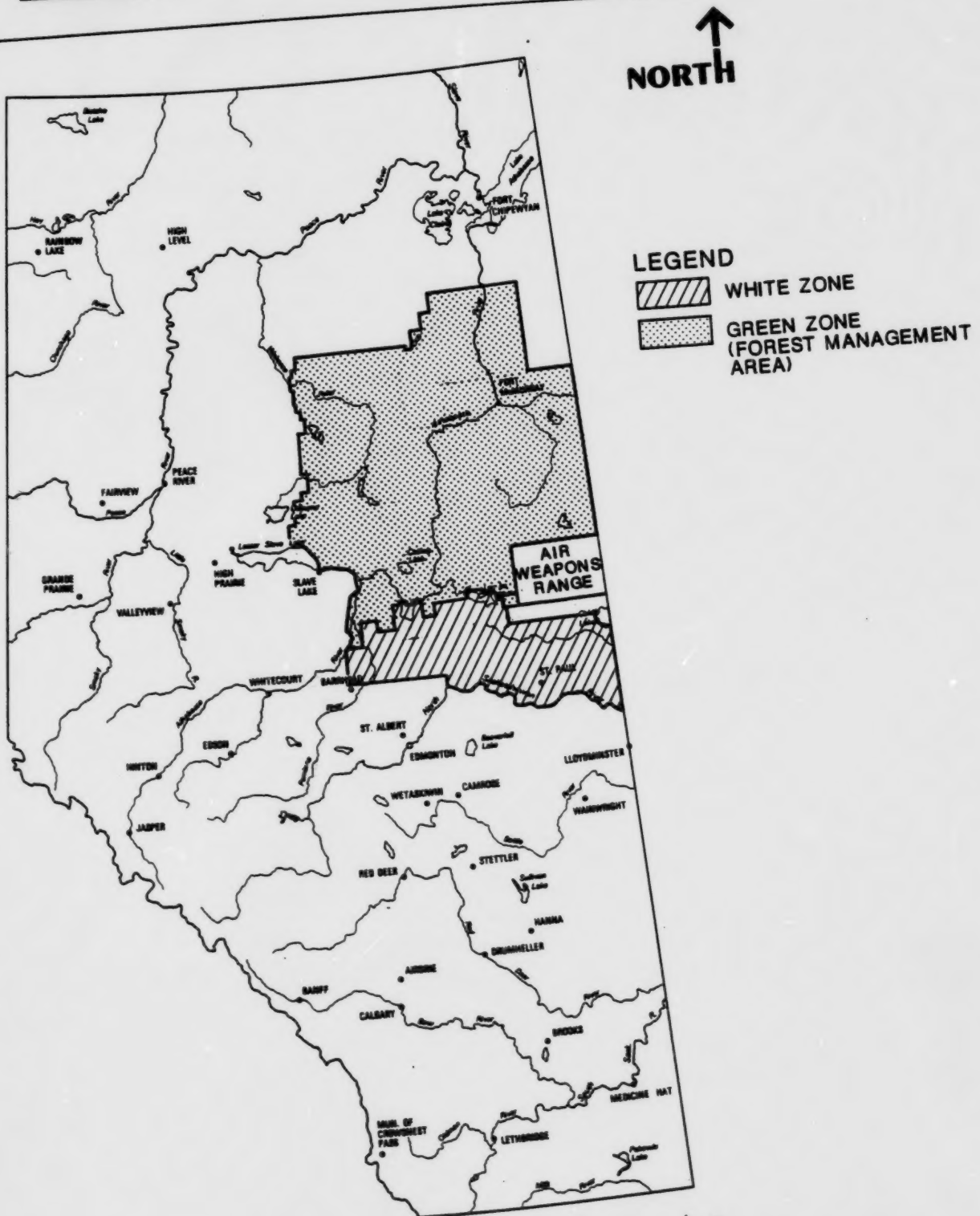


Figure 2.3

**PROPOSED WOOD
SUPPLY AREAS**

Because of mill inventory requirements and logging conditions, roundwood will be delivered in both the summer (June 1 - November 14) and winter (November 15 - March 14) seasons, with an emphasis on winter delivery. No deliveries are scheduled for the spring break-up period (March 15 - May 31). Proposed roundwood deliveries in the short and long term are summarized in Table 2.2.

Table 2.2 Roundwood deliveries to the mill (thousands of m³/year).

	Summer	Winter	Total
Company coniferous	51	172	223
Company deciduous	407	1203	1610
Purchased deciduous	28	250	278
Total	486	1625	2111

Company deciduous and coniferous roundwood will be harvested by independent contractors in the Green Zone; purchased deciduous roundwood will comprise 123,000 m³/year from the White Zone and 100,000 m³/year of exchange logs from established conifer quota holders. All roundwood will be trucked to the mill by independent contractors.

Residual softwood chips will be purchased from sawmills in the Athabasca - Lac La Biche - Fort McMurray area and will also be hauled to the mill by independent contractors.

Table 2.3 lists average daily truck deliveries to the mill of chips and roundwood. The figures in Table 2.3 are based on the following assumptions:

- net hauling days: 93 in summer and 92 in winter
- average loads: chips, 50 m³; coniferous roundwood, 46 m³; deciduous roundwood, 37 m³.

Table 2.3 Average numbers of daily truckloads of wood supply to the mill

	Chips	Roundwood			All Loads
		Coniferous	Deciduous	Total	
Summer	28	6	130	136	164
Winter	28	59	394	453	481

2.3.2 Transportation

Rail haul of logs has not yet been investigated as a possible hauling method. There are no other rail hauls of logs in Alberta, and few in Canada. The company may however wish to pursue this option in the future in view of its experience and success at rail log haul in British Columbia.

Road haul of logs, both summer and winter, is planned for transport of logs from woods to mill.

The proposed wood supply area has relatively good access through existing roads built by various levels of government and by timber and energy companies, but a major capital investment will nevertheless be needed to provide the most direct access to operating areas. Two major new road systems will be required, one to the northwest of the mill and the other to the east and northeast (Figure 2.1; Section 2.5.5).

Initial mill roundwood supplies will be scheduled for winter delivery over existing public roads to permit lead time for construction of the new road systems. With careful harvest planning it will be possible to supply the mill using existing public and private road infrastructure until the first stages of the new road systems are completed.

2.3.3 Forest Management Agreement

Alberta-Pacific Forest Industries will enter into a Forest Management Agreement (FMA) with the Government of Alberta to assure a wood supply for the pulp mill. An FMA gives the operator the right to harvest a specified quantity of timber in the context of sustainable yield, while specifying forest management responsibilities in the areas of:

- restocking of logged forest areas;
- adherence to specified standards of recovery and utilization; and
- cooperation with the government in protecting against fire, insects and disease.

Development of a forest management plan that will ultimately transform the variable and low-intensity mixed species timber presently in the area into well-managed, high density stands is one of Alberta-Pacific's long-term objectives.

In Alberta, forest management agreements are administered by the Alberta Forest Service. All issues of environmental impact relating to the forests, including wildlife, fisheries, water yield, water quality, recreation, trapping and other land uses are considered in the context of the FMA. Thus it is not appropriate to consider FMA-related environmental impacts within this EIA report. These aspects will be addressed in a separate forest management plan to be reviewed and approved by the Forest Service.

2.4 PROCESS FLOW

2.4.1 Kraft Pulping

Some 81.5 million tonnes, or about 70% of the world's annual production of pulp is produced by the kraft process. There are 47 operating kraft mills in Canada, 2 of which are in Alberta: one at Hinton and the other at Grande Prairie. The kraft process is dominant because it:

- is a well proven technology;
- can be used to pulp all species of hardwoods and softwoods;
- produces strong high quality pulp that can be economically bleached to a high degree of brightness;
- regenerates its own cooking chemicals through an integrated chemical recovery process; and
- is practically self-sufficient in energy through combustion of waste products.

In addition to these advantages, Alberta-Pacific's selection of the kraft process for the mill is based on its parent companies' judgement as to what the paper markets of the future will require. The trend in global paper and board markets is anticipated to continue to rise, and a large portion of the growth is expected to be in printing and writing paper. In order to enter this market, it is necessary to produce a high grade chemical pulp; pulps produced by mechanical and semi-mechanical processes such as CTMP are not adequate. The kraft process remains the top conventional process for the production of market grade chemical pulp because it:

- has a higher rate of delignification,
- is more adaptable to different species of wood, and
- produces a better quality of pulp at a lower cost.

The "Organosolv" pulping techniques, which use organic solvents such as ethanol and methanol at high temperature and pressure to dissolve lignin from wood chips, show the promise of providing a sulphur-free, easier bleaching route to market grade chemical pulp. Organosolv techniques are in use in at least two demonstration plants but have not as yet been proven at a commercial scale of production.

The objectionable odours sometimes associated with kraft mills in the past have been greatly reduced in modern mills with the development of improved designs for digesters, evaporators and recovery furnaces.

Technological advances in process design and effluent treatment have also greatly reduced emissions of sulphur, BOD, and chlorinated organic compounds.

2.4.2 Products

The products of the pulp mill at full annual production capacity will be 390,000 air dried tonnes (ADt) of bleached kraft hardwood (mainly aspen) pulp and 106,250 ADt of bleached kraft softwood pulp. These will be high quality pulps for use primarily in permanent printing and writing papers and will be produced to meet the specifications of the international market.

Pulp produced from aspen is a relatively new product in Western Canada; however, aspen has been successfully pulped alone or mixed with other hardwoods in eastern Canada and the northeastern United States for many years. Aspen wood has a relatively low lignin content, which helps make it easy to pulp and bleach. Aspen also has relatively low density and it has relatively slender, flexible fibres, somewhat similar to those of plantation Eucalyptus. Kraft pulp made from aspen wood has about 70% of the strength of a mixed spruce pulp.

Compared to other hardwood pulps, aspen pulp is grouped with eucalyptus and birch in a category that finds ready acceptance for their papermaking qualities. Aspen pulp has desirable properties for use in printing and writing paper grades and should also prove desirable in solid bleached board products used for packaging of frozen foods and liquids, where surface qualities relating to printability are important. Aspen pulp is also suitable for making tissue papers because of its absorbency and the relative softness of its fibres.

LOGS TO CHIPS

- 1 Tree length aspen logs are transferred by cranes from storage on to a deck. Truck deliveries of wood already cut to 2.4 m length are also unloaded and fed into the system. All deliveries will be scaled.
- 2 The logs then pass through debarkers where the bark is removed and prepared for use as fuel. The logs become chips as they pass through slotted rotating discs equipped with a knife blade in each slot. The chips are screened to remove oversize material. The chips are conveyed to storage piles for later use or alternatively fed to chip screening to remove oversize slivers and fines. By-product softwood chips from sawmills, which arrive by truck, are stored outside prior to use in the pulp mill.



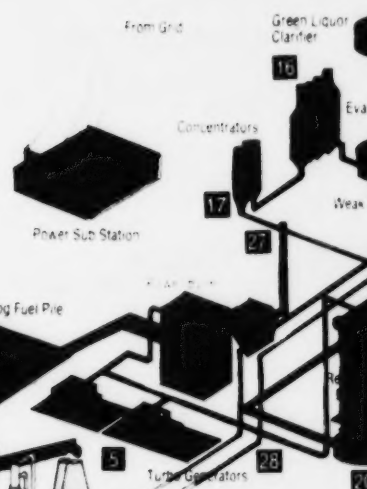
CHIPS TO BROWN FIBRE

- 4 Chips pass to a chip bin and steam vessel. The steam preheats the chips, drives out the air, and opens the wood pores to allow the cooking liquor to soak more completely into the wood. The cooking liquor, a water solution of sodium hydroxide (NaOH) and sodium sulphide (Na₂S), is forced into the chips at high pressure in the impregnation vessel. The impregnated chips then pass into the digester, where at controlled high pressure and temperature, the chemicals dissolve the lignin (a natural glue) that holds the wood cells (fibres) together. The stock leaving the digester is debarked, except for some oversized chips and knots containing dense wood. These large pieces are removed with knotters and recycled through the digester. A two stage diffusion washer separates the spent chemicals from the brown fibre. This dilute spent chemical solution (black liquor) is used in a washing zone in the bottom of the digester. After this stage, the black liquor is "thickened" (see item 16) or concentrated prior to going through the recovery system and is reconverted into active cooking liquor.

- 5 The brown fibre is screened to remove small slivers and then thickened to prepare it for additional removal of lignin in the oxygen delignification stage. Oxidized white liquor, prepared at the causticizing plant, and oxygen gas are mixed with the stock ahead of the oxygen reactor, where at controlled temperature and pressure the oxygen dissolves additional lignin. The solution containing the dissolved material is removed by a table washer and this solution (black liquor) is used countercurrently at the decker and screens. The washed stock is then pumped directly to the first stage of bleaching.

CHEMICAL RECOVERY PROCESS

- 6 Spent cooking liquor or "black liquor" is an 18 percent solution of spent chemicals and dissolved wood material composed mainly of lignin. Steam heated multiple effect evaporators concentrate it to 55 percent solids. The liquor is finally concentrated to 70 percent solids in a high solids crystallizer. The concentrated liquor is then fired in the boiler as a low grade fuel. Sodium sulphate dust in the boiler gases is removed by an electrostatic precipitator.
- 7 Combustion of the liquor produces energy for the mill. The chemicals form a bed in the bottom of the furnace. Sodium carbonate (Na₂CO₃) and sodium sulphide (Na₂S) drain out from the bed as a molten smelt and are dissolved in a tank. Carbon and other impurities in this green liquor are settled out in a clarifier, filtered and used as landfill.



- 8 Clarified green liquor is mixed with lime in a slaker where two chemical reactions take place. First the lime slakes in the water of the solution: $\text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2$. Second, the calcium hydroxide reacts with the sodium carbonate to produce sodium hydroxide (NaOH) and calcium carbonate (CaCO₃): $\text{Na}_2\text{CO}_3 + \text{Ca(OH)}_2 \rightarrow 2\text{NaOH} + \text{CaCO}_3$.
- 9 This reaction proceeds into the causticizer reactors. The calcium carbonate is an insoluble mud that is removed by filtering it from the liquor (now called "white liquor").

- 10 White liquor, a solution of sodium hydroxide (NaOH) and sodium sulphide (Na₂S), active cooking chemicals, is ready to be mixed with fresh wood chips. The calcium carbonate mud is washed, filtered and then fired in a kiln where it is converted back into lime suitable for slaking more green liquor: $\text{CaCO}_3 + \text{heat} \rightarrow \text{CO}_2 + \text{CaO}$.
- 11 Oxidized white liquor for the oxygen delignification process is prepared in a reactor vessel using oxygen gas. The oxygen reacts with the sodium sulphide (Na₂S) in white liquor to oxidize the sulphide component which otherwise would consume oxygen in the delignification stage.

ENVIRONMENTAL CONTROL

- 12 Effluent treatments include neutralization of bleaching effluent, primary treatment by sedimentation and secondary treatment in an aeration lagoon. An emergency spill basin is included as part of the effluent treatment system complex. The sludge from the primary clarifier is dewatered, pressed and then burned in the power boiler. The system is designed to meet stringent requirements in BOD₅, total suspended solids and toxicity.
- 13 Air particulate emissions are controlled to meet environmental agency requirements by the use of electrostatic precipitators, scrubbers and cyclones.
- 14 Non-condensable gases are incinerated in the lime kiln. A low odour recovery boiler is installed. Evaporator condensate is steam stripped and reused.

STEAM AND POWER PLANT

- 15 Steam is produced in both the chemical recovery and power boilers. This steam is passed at high pressure to steam turbines which turn electrical generators to produce electricity. The plant is normally self-sufficient, but for start-up conditions and for when the in-plant generator is not operational, a link to the outside power grid is supplied.

BROWN FIBRE TO WHITE FIBRE

- 9 Bleaching is a continuous process carried out in three towers under exact temperature and chemical conditions. After each tower, drum washers remove the spent solution. The filtrate is used in counter current washing in the bleach plant. Filtrate overflows are treated in primary and secondary treatment areas. The sequence of chemical treatment is: chlorine (Cl₂) with chlorine dioxide (ClO₂), sodium hydroxide (NaOH) with some oxygen, chlorine dioxide (ClO₂), sodium hydroxide (NaOH), and finally chlorine dioxide again. These chemicals ensure maximum economic purification and whitening with minimum damage to the fibre quality.
- 10 Chlorine dioxide is produced by a low chlorine byproduct process on site.
- 11 After screening, the fibre is passed through centrifugal action cleaners which remove small dense impurities.

PREPARATION FOR SHIPMENT

- 11 Water is then removed to prepare the pulp fibre for shipment to papermills. (The papermills will add water and resins the fibre in the papermaking process).
- 12 To achieve this the dilute fibre-water mixture is metered onto a pulp machine. Water drains through the machine screen, first by gravity then by suction, leaving a mat of fibre on top. This wet mat or web is strong enough to be continuously drawn off and passed between press rolls where more water is squeezed out. The continuously moving web passes through a steam-heated airborne dryer where final water removal takes place by evaporation. The pulp web is then cooled and cut into sheets. The sheets are pressed into compact bales, wrapped, wired and stamped for shipment. The mill capacity is 1500 air dry tonnes per day of prime quality pulp.

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VANCOUVER, CANADA

DIAGRAMMATIC PROCESS FLOW

P. 3605 B

FIGURE 2.4

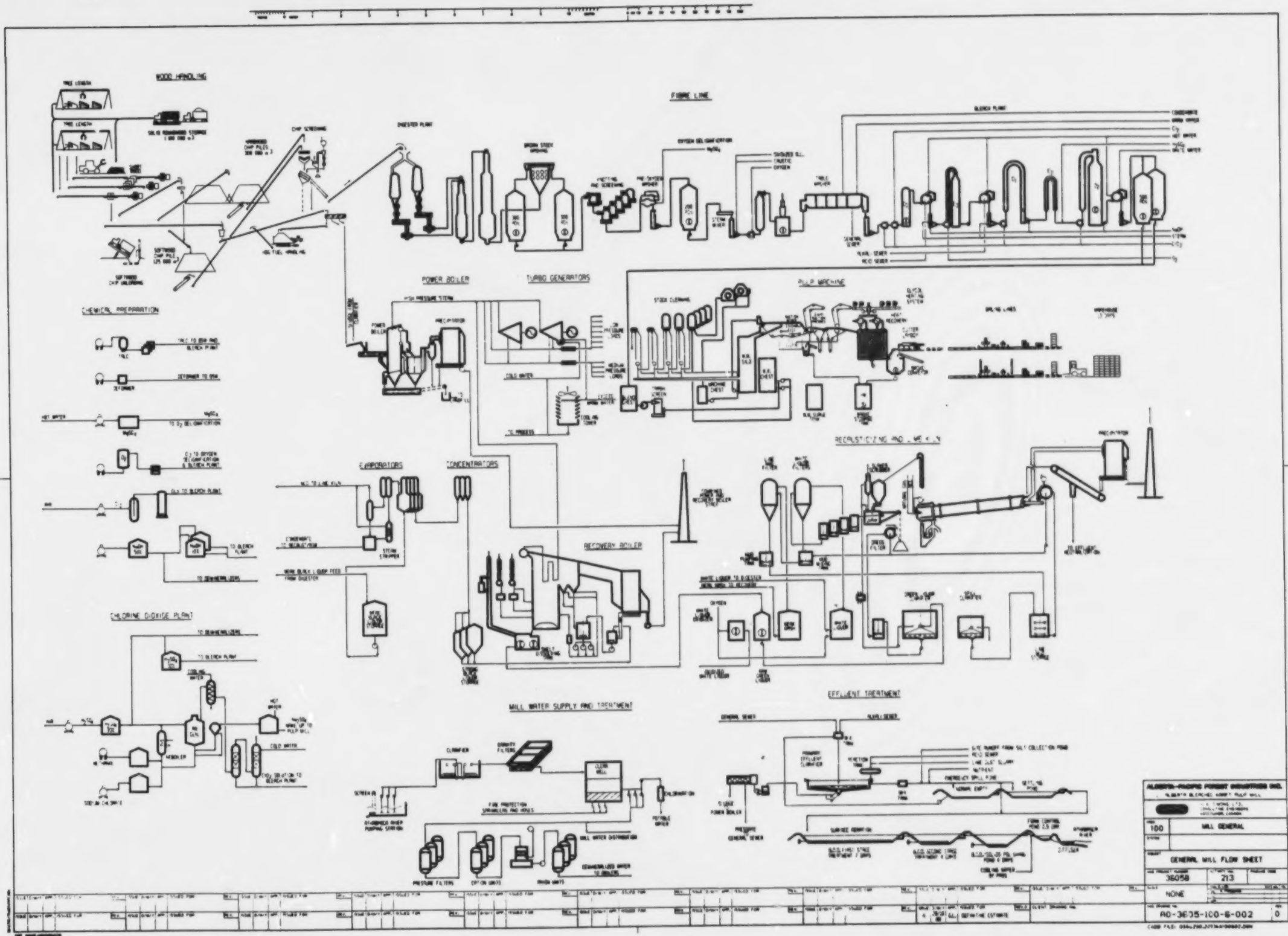


Figure 2.5

GENERALIZED MILL
FLOW SHEET

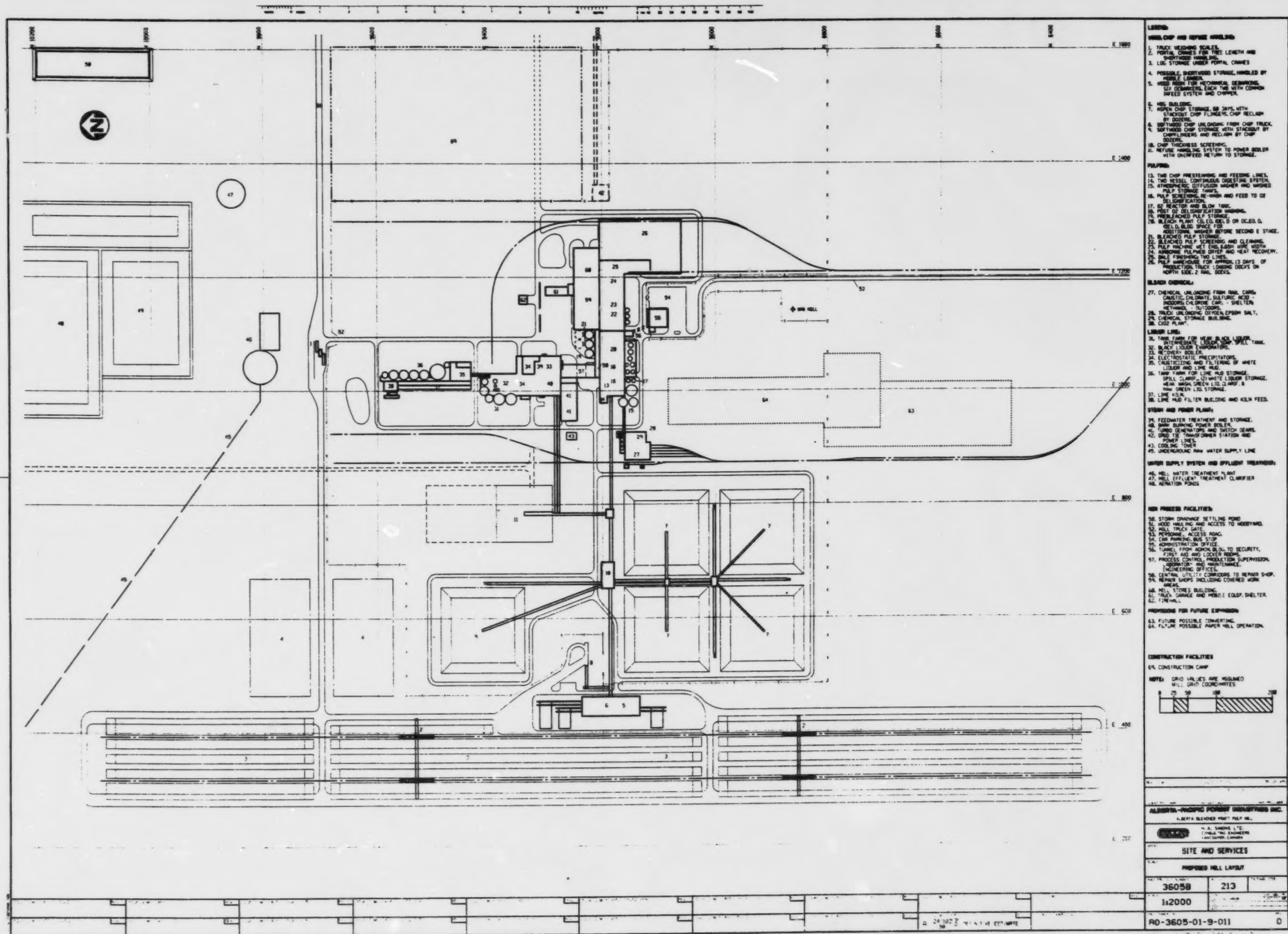


Figure 2.8

DETAILED MILL SITE LAYOUT

2.4.3 Process Description

Design Criteria

The kraft process proposed for the mill is depicted in a generalized graphic form in Figure 2.4. A generalized mill flow sheet for the kraft mill is shown in Figure 2.5, while Figures 2.6 and 2.7 give the overall mill material balances for hardwood and softwood, respectively. The pulp mill is designed as a single-line operation that alternatively produces fully bleached hardwood and softwood pulps in separate runs. Twelve hardwood/softwood cycles per year are envisioned. Changeover from one species to the other will be accomplished without mill shutdown; a mixed species "twilight pulp" will be produced during the short transition period.

Mill Layout

Details of the mill site layout are shown in Figure 2.8. All process buildings are contiguous and are arranged around a central control room. This design provides for the most efficient operation, especially in the cold winter conditions experienced in northeastern Alberta. The mill layout could easily accommodate long range expansion options.

Wood Storage and Preparation

Hardwood furnish for the project will be primarily tree length aspen logs and some 5 m logs. Softwood furnish will be sawmill chips and roundwood. Sufficient inventory of roundwood will be stored in the wood yard to carry the operation during the spring break-up period, when there will be no roundwood deliveries, and to partially carry it during summer, when wood procurement is more difficult and road hauling restrictions are in effect. It is anticipated that chips will be

available throughout the year. A maximum log inventory of 1,100,000 m³ will occur around mid-March.

Tree length logs will be unloaded and stored by means of portal cranes. Short (5 m) logs will be handled by front-end loaders or portal cranes at a short log storage area. Hardwood and softwood logs will be stored separately. Sawmill chips will be unloaded by a truck dumper and stored in an outdoor pile.

Roundwood will be mechanically debarked and chipped, the chips being stored in separate outdoor hardwood and softwood piles designed for rotation of chips. Bark and other waste will be collected by a conveyor system and fed to a hogger for processing as power boiler fuel. The hogged fuel will be conveyed to a hog fuel storage pile.

Pulping, Washing and Screening

Chips reclaimed from the storage piles will be fed through a thickness screening system which will remove metal and stones, slice overthick chips to an acceptable size, and remove fines and pin chips. The fines will go to hog fuel and the pin chips will be metered back in with the accepted chips. The screened chips will then be conveyed to the digester.

The continuous digester system will be equipped for Kamyr's modified continuous cooking process and will consist of a dual chip feed line, two chip steaming vessels, a single impregnation vessel and a single hydraulic type digester. In this system, an alkaline cooking solution of sodium hydroxide (NaOH) and sodium sulphide (Na₂S) is introduced with the chips entering the impregnation vessel and also at other points in the cooking system. Cooking takes place at elevated temperature and pressure in the digester. During cooking, the lignin binder and other non-cellulosic materials in the wood chips are

dissolved in the cooking liquor and the cellulosic fibers are liberated. The digester will be designed for separation of cooking liquor (weak black liquor) and efficient recovery of waste heat.

The digester will discharge cooked pulp into an atmospheric two-stage diffusion washer, which will discharge into either of two storage blow tanks. The pulp will then be pumped through pressure knotters and pressure screens and on to two washers in parallel. Large undercooked knots or other material will be removed in two stages of knotters, while smaller fibre bundles will be removed in four stages of screening. The knots will be drained, pressed and returned to the digester feed system for re-cooking while the screen rejects will be conveyed to hog fuel.

The washed and screened pulp will be treated with oxygen gas and oxidized white liquor in a medium consistency oxygen delignification treatment followed by washing on a table washer. The waste cooking and oxygen delignification liquor will be fully recovered for its heat and chemical values.

Bleaching

The pulp will be bleached by a D/C E₀ (DED) sequence. The amount of elemental chlorine required will already have been reduced by the oxygen delignification treatment; it will be further reduced during the bleaching process by employing 70% substitution of chlorine dioxide for both hardwood and softwood production. This will reduce the quantity of chlorinated organic substances in the effluent well below the levels currently possible with conventional bleaching technology. A multiple chemical addition system will be used in the first bleaching stage to further reduce the potential for dioxin production. Softwood pulp will be bleached to 90% ISO brightness and hardwood pulp to 91% ISO brightness.

Pulp Cleaning and Finishing

After pressure screening and cleaning in a five stage centrifugal cleaning system, the bleached pulp will be thickened and sent to the pulp machine. The pulp machine will include a fourdrinier section to dewater the dilute pulp-water slurry, followed by a press section and a steam heated air float drier. Pulp will be baled and finished in a highly automated operation. The unitized pulp will be stored in a warehouse or loaded directly into rail cars for shipment.

Chemical Recovery

In order to reclaim cooking chemicals, the spent solution of cooking chemicals (weak black liquor) will be pumped from storage to a five-effect evaporator train followed by a three-stage concentrator, which will thicken the black liquor from 16% to 70% solids. This strong black liquor will be sprayed into the recovery boiler where the organic components will be completely oxidized. The inorganic components will be converted to sodium sulphide (Na_2S) and sodium carbonate (Na_2CO_3) in the reducing zone of the recovery boiler and will flow out of the bottom of the furnace as a molten smelt. Smelt runoff from the boiler will be dissolved in weak wash from recausticizing to produce green liquor, which will be pumped to the recausticizing department. Recovery boiler flue gases will be drawn through electrostatic precipitators of 99.5% efficiency by large fans and discharged to atmosphere via a stack. Smelt dissolving tank gases will be scrubbed and vented via a stack. The recovery boiler will utilize an optimized stationary firing system to maximize the bed burning temperature and thereby minimize sulphur dioxide emissions.

The recovery boiler has been sized on the basis that part of the strong black liquor will be stored during softwood runs and returned during hardwood runs so as to provide a uniform energy input into the recovery

unit. Additional storage has been provided for this purpose and the total storage is about twice the amount normally available in a softwood only chemical recovery plant. The recovery boiler is designed to oxidize 2,200 tonnes per day of black liquor solids.

Recausticizing and Lime Reburning

Raw green liquor from the recovery smelt dissolving tank will be clarified and recausticized with lime (CaO) to produce white liquor. The regeneration of cooking liquor will be completed by filtering the calcium carbonate (CaCO_3) mud from the white liquor. Washed and filtered calcium carbonate will be burnt to calcium oxide (CaO) in the lime kiln, the exhaust gases being electrostatically cleaned and discharged to the atmosphere via a stack. The make-up chemicals to the chemical recovery cycle are purchased lime (calcium oxide) and sodium hydroxide, and sodium sulphate (Na_2SO_4), which is a by-product of chlorine dioxide generation.

Steam Supply

Process steam requirements will be made up principally from the chemical recovery boiler, the balance of the steam being generated by a hog fuel/natural gas fired power boiler that will permit optional burning of chip fines, hogged bark, other waste wood, dewatered screen rejects, and pressed sludge from the effluent treatment system. Gas burners designed for 100 percent of boiler capacity will ensure a continuous, reliable fuel supply. High efficiency dust collectors and an electrostatic precipitator will be served by a particulate handling and disposal system. The power boiler will generate steam at a pressure of 6.2 mPa and will have a maximum rated steaming capacity of 270 t/h (tonnes/hour) when burning hog fuel and 320 t/h when burning natural gas. The design bed temperature in the power boiler is 1470°C and the average temperature in the boiler over a three second retention

time will be 11200C. At full mill operating capacity, the recovery and power boilers will provide 66% and 25% of mill energy requirements, respectively.

Auxiliaries for both recovery and power boilers include polishers for condensate returns, demineralizers for make-up feed water, a deaerator and storage, and boiler feed water pumps.

The total volume of steam generated from the boilers will be passed through turbine generators at high pressure to produce electricity. Medium and low pressure steam leaving the generators will be used for process purposes.

Power Supply

The mill's principal power requirements will be provided by a 40 MW single extraction back pressure turbine generator and a 40 MW double extraction condensing unit. There will also be a tie to existing electrical utilities (see Section 2.5.2) to supply start-up and emergency power.

Water Supply

A pumping station on the Athabasca River will supply raw water to the mill. Water will be treated for both process and potable water requirements (see Section 2.5.4).

Effluent Treatment

Effluent treatment will include neutralizing of bleaching effluents, primary treatment by sedimentation, and secondary treatment in an aeration lagoon. An emergency spill basin will also be included as part of the effluent treatment system complex. Discharge of treated

effluent will be through a diffuser into the Athabasca River. Details of the effluent treatment systems are provided in Section 3.2.

Process Control

A state-of-the-art, computer based distributed control system (DCS) using electronic instruments will effect process control from a central control room, except where operators must be close to process equipment. The DCS will consist of distributed controllers, operator stations, and the communications network, which will include five satellite control rooms for: pulp machine wet end and bleach screens, dry end, lime kiln and recausticizing, water and waste treatment, and chip handling. The DCS will provide basic regulatory control, discrete logic control and sequencing, and area and unit process optimization and will interface to the millwide computer system. The DCS will be used to optimize digesting, recausticizing, bleaching, and power system energy management, as well as providing a window to all measuring and control functions related to wood chips, hog fuel, other mill processes, and environmental control equipment.

2.5 UTILITIES

2.5.1 Chemical Receiving and Preparation

During Alberta-Pacific's discussions regarding project impacts with the public, considerable concern was raised, particularly by the residents of Boyle and by landowners along the proposed transportation corridor, regarding the amounts and types of chemicals coming to the mill and the proposed handling procedures.

The quantities of chemicals that will be brought to the mill site are shown in Table 2.4.

Table 2.4 Chemical requirements of the pulp mill

Chemical	Process	Usage, tonnes/year Water Treatment	Effluent Treatment	Total
Lime	8,630	3,500		12,130
Sodium hydroxide	12,050			12,050
Sodium chlorate	11,330			11,330
Oxygen	10,960			10,960
Sulphuric acid	9,960			9,960
Chlorine	3,160	100		3,260
Carbon dioxide		2,000		2,000
Alum		450	1,500	1,950
Talc	1,330			1,330
Salt	1,260			1,260
Methanol	1,000			1,000
Defoamer			840	840
Magnesium sulphate	720			720
Dispersant	430			430
Anhydrous ammonia			200	200
Phosphoric acid			100	100
Polymers		10	60	70
Sodium bisulphite	7			7

It is anticipated that an average of 5 to 6 rail cars per day will be required for chemical delivery. Deliveries of chemicals by truck will average 2 to 4 per day, depending primarily upon whether lime is delivered by rail or truck. In addition to the chemicals listed above, 7,700 metric tonnes per year of chlorine dioxide (ClO_2) will be produced on site.

Sulphuric acid will be delivered by rail to the mill site at 98% concentration and stored in a mild steel tank. Liquid methanol will be supplied by rail and will be unloaded into an on-site storage tank remote from the main chemical storage area. Sodium chlorate will be supplied by railcar as crystal; the crystals will be dissolved in the car and pumped to FRP storage tanks. Sodium hydroxide will be supplied as 70% caustic by rail; it will be diluted and stored at 50% or 10%

concentration. Chlorine will be supplied and stored in liquid form in railcars, and will be unloaded directly to the process. Oxygen will be delivered in liquid form by truck and will be stored on site in outdoor insulated vacuum tanks. Lime will be supplied by rail or truck in powdered form and blown into the storage facility. Talc will be supplied in bulk by railcar and blown into an on-site storage tank. Magnesium sulphate will be supplied in 25% solution by truck and unloaded to a storage tank. Phosphoric acid and alum will be delivered in liquid form by railcar to the site. Anhydrous ammonia will be supplied as a liquified gas, also by railcar. Polymer will be delivered by truck or railcar as a dry powder. Pitch dispersant and defoamer will be delivered in bulk or in drums by truck and stored on site as required. Carbon dioxide will be delivered in liquid form by truck or will be produced on site by burning natural gas under water.

All chemical unloading and handling areas will be designed to allow containment of spilled chemicals. Surface runoff from the chemical receiving and storage areas will be routed to the effluent treatment system, with provision being made to divert chemical-contaminated runoff to the emergency spill basin (Section 3.6.2).

2.5.2 Electric Power

As indicated in Section 2.4.3, the mill will be self-sufficient in electric power except for start-up, peak loads, and emergency situations. External power will be purchased from TransAlta Utilities by means of 34 km of new 30 MW, 138 kV power line that will tie into an existing transmission line about midway between Boyle and Plamondon. Temporary power for construction purposes will be provided by a 25 kV tie to the existing transmission line.

2.5.3 Natural Gas

Natural gas will provide the primary fuel to the lime kiln and gas-fired building heating equipment and will serve as supplementary or backup fuel for the power boiler and recovery boiler.

Natural gas will be obtained from the NOVA gas pipeline that currently passes through the proposed mill site.

2.5.4 Water Supply

The mill water supply will be taken from the Athabasca River. The mill will require an ultimate raw water supply capacity of 1.55 m³/s (134,000 m³/d).

Water will be drawn from the river via an open channel intake through trash racks, sluice gates and travelling screens to remove coarse debris. The water will then be pumped to the mill by means of a 5.5 km, 914 mm (36") buried pipeline laid alongside the right-of-way of the existing NOVA gas pipeline. The pipeline will be buried in a common ditch with a 304 mm (12") warm water return line. The warm water line is designed to provide warm water at the pumphouse to protect against frazil ice and against any icing conditions that might occur at the travelling screens.

At the mill, the raw water will be treated with lime, alum and polymer at the cold water treater to produce a softened, clarified water. The water will then be filtered through a vacuum filter system on its way to the clearwell, from which water will be pumped for process requirements throughout the mill.

Approximately 90% of water withdrawals will eventually be returned to the river, 55% as treated effluent and 45% as clean cooling water that

does not require treatment. Solids removed from the raw water will be sent to landfill.

2.5.5 Roads and Rail Lines

Access to the mill site will be by a combination of rail lines, upgraded roads and new roads. The components of the transportation infrastructure network are shown in Figure 2.1 and described below as they are currently envisioned.

Rail

Rail access will be provided by construction of a spur line leading north approximately 36 km from the existing CNR line at Boyle to the mill site. The rail line will run parallel to Highway 63 and 800 m to the east of Boyle to a point about 2 km north of Donatville, where it will trend northwest and then north again to the mill site. Railroad construction will comply with Alberta, Canada, and CNR regulations and standards.

It is assumed that the rail spur extension will be operated by CN, probably on a daily round trip basis with 1 or 2 power units, the latter providing for up to 65 rail cars per trip. The track design standard will permit an average operating speed between Boyle and the pulp mill of approximately 50 km/h. Details of the spur line design and construction are currently under consideration.

New and Upgraded Roads

New and upgraded roads in the mill site area (Figure 2.1) will be required to provide construction and operation access into the mill and to provide alternate access to farms due to 5 km of road closures that will be necessary within the mill site.

Alberta Transportation is planning the following new road infrastructure:

- a new bridge across the Athabasca River about 7 km west of the mill site;
- a new highway from Calling Lake via the new bridge to the mill site and then 21 km east to Highway 63; and
- a new southern highway link along the west side of the mill site and following in part the rail spur corridor.

As well, it will be necessary to upgrade 6 km of existing county gravel road to link Highway 63 to the north-south access highway. Alberta Transportation has selected the routes for the proposed new highways and will be responsible for addressing their impacts.

Alberta-Pacific is planning the following additional new and upgraded roads:

- a partially new, partially upgraded 4 km perimeter road around the east side of the mill site;
- a 2.5 km connector to the highway 63 logging road; and
- a 1.5 km addition to the local county road system to rejoin the Spruce Valley road to the local road system west of the mill site.

Approximately 5 km of new gravel roads will also be required to provide access to the water intake and effluent outfall facilities.

Details of the log haul road network north of the Athabasca River, which will be subject to a forest management agreement, will be provided in a separate report submitted to the Alberta Forest Service.

The estimated daily numbers of truck deliveries to the mill site during the construction and operation periods are summarized below:

Construction

1989 July to Dec	50
1990 Jan to June	200
1990 July to Dec	30
1991 Jan to June	50

Operations

	<u>Summer</u>	<u>Winter</u>
Chips	28	28
Logs	136	453
Chemicals	2-4	2-4
Supplies	1	1
Total	169	486

2.6 FIRE PROTECTION, EMERGENCY AND SAFETY SYSTEMS

2.6.1 Fire Protection

A detailed fire protection plan will be developed to meet the requirements of the National Fire Protection Association.

The primary fire protection water supply will be from the clearwell reservoir, which has a total capacity of 6,000 m³, of which about 2,000 m³ will be dedicated for fire protection.

The clarifier will provide a back-up water supply of 7,600 m³. The clarifier is supplied from the river pumps, which can provide approximately 252 L/s above the normal mill water supply.

Two electric pumps and one diesel fire pump, each rated at 9,500 L/min at 862 kPa, plus a 570 L/min jockey pump, will be provided. They will normally draw from the mill water storage tank, but in case of impairment or exhaustion of that supply, they will draw from the reactor clarifier. A dual feed from the fire pumps will supply underground looped fire mains throughout the mill.

Hydrants spaced at 90 to 100 m on looped systems will be provided around the buildings. The chip storage and hog fuel storage areas and the log storage and handling area will have a combination of control loop and single line feeder extensions.

A fire truck with a roof mounted monitor nozzle will be provided.

Automatic sprinkler systems, stand pipes and a hose system designed to the appropriate fire protection codes are included in the preliminary mill design.

A multiplex fire alarm and detection system will be provided, with a central control panel and CPU located in the power plant control room, and an annunciator panel located in the guard house. The system will monitor the following items:

- smoke detectors in all electrical, MCC and switchgear rooms;
- sprinkler system water flow switches;
- fire protection system gate valve tamper switches;
- manual pull alarm stations in all buildings;
- heat detectors in control rooms;
- tripping of pre-action valves; and
- operation of fire pumps.

Fire response and fire fighting training will be provided for pertinent mill personnel. Portable fire protection equipment will be provided as required to supplement permanent hydrant, hose and sprinkler systems. Fire extinguishers will be provided in all buildings and in all

electrical, control and rack rooms. In accordance with the Montreal Protocol, there will be no halon systems in the mill.

2.6.2 Safety and Emergency Response Systems

The proposed pulp mill has state-of-the-art control systems including computer technology to independently control all process components of the mill. Manual overrides will also be included to ensure that the system can be operated properly under all conditions. Liquid storage tanks will be equipped with berms and monitoring systems as required. Individual unloading systems for each chemical will have a unique connection to ensure that unloading can only occur to the proper tank. Trucks and railcars will be unloaded directly under the supervision of mill staff to ensure that proper safety procedures are followed.

The mill will be equipped with alarm systems to alert all staff on site in the event of an emergency. In accordance with Alberta Occupational Safety and Health Requirements, appropriate training programs will be conducted for mill staff to ensure a safe work place.

Visitors to the mill, in accordance with normal industrial practice, will be briefly instructed on mill safety procedures and their access will be restricted to specific areas.

A detailed mill safety and emergency program satisfying the requirements of the Alberta Occupational Health and Safety Branch will be developed. The program will be based on Crestbrook Forest Industries' safety and emergency program for the Skookumchuck mill and will include response procedures for:

- gas emergencies,
- power and recovery boiler emergencies,
- tank car emergencies, and
- fire response.

2.6.3 Spill Response

An emergency spill pond will be provided to handle any malfunction or upset that cannot be contained by the extensive in-plant spill control system. This spill pond will be sized to accept 24 hours of total mill effluent, which will ensure that a rare spill event does not adversely affect the primary clarifier or aeration lagoon, or cause a direct discharge to the river. Effluent contained in the spill pond will be metered into the effluent treatment system at a rate that will not adversely impact the treatment process. Details of the spill control system are provided in Section 3.6.

2.6.4 Railway Safety

The "special commodities", or dangerous chemicals, that will be transported to the mill by rail include sodium hydroxide (caustic soda), chlorine and sulphuric acid. All rail shipments of dangerous chemicals will comply with applicable federal government regulations, which require for each shipment:

- a detailed shipping document that identifies and classifies the chemical and that provides all information pertinent to its safe handling, as well as a 24-hour emergency telephone number;
- an emergency response form for each carload that identifies the chemical, lists its potential hazards, and provides immediate action information including a 24-hour emergency telephone number; and
- placards on the sides and ends of all rail cars that provide identification and precautionary information.

CN also incorporates its own procedures to ensure the safe transportation of dangerous goods. These procedures are:

- use of computer programs to provide immediate emergency response information on dangerous goods;

- maintenance of a fleet of special emergency response vehicles to provide communications and technical support; and
- use of trained special commodity officers to monitor and promote the safe and efficient handling of dangerous goods.

In addition, all CN chemical tank cars are currently being equipped with "double shelf couplers", which insure against the coupler puncturing the adjacent tank car in the event of a derailment or other emergency stop.

2.7 PROJECT IMPLEMENTATION

Alberta-Pacific Forest Industries Inc. will initially implement the project from its Edmonton head office, directing the activities of consultants, contractors, equipment vendors and suppliers with respect to the engineering, procurement, construction and staffing for the project from that location. The project focus will shift from Edmonton to the site as soon as an administrative office is constructed on the site (planned for 1990). The Woodlands Division will continue with development of wood harvesting plans and associated infrastructure and will commence the delivery of wood to the site at the appropriate time.

Alberta-Pacific's management and consultants will interface with the appropriate Alberta Government ministries and agencies with respect to requirements for infrastructure. Environmental impact assessment work will be refined as required in the context of continued discussions with Alberta Environment.

Procurement of major, long delivery equipment and preparation of detailed engineering design drawings and specifications is expected to commence in spring 1989, with construction scheduled to begin as soon as the environmental impact assessment is approved and permits are issued. Additional topographic surveys and soil testing will be required to confirm preliminary data based on the latest mill site layouts.

Construction completion, testing and check-out is scheduled in progressive manner for major areas, leading to mill start-up in late 1991.

Up to 1900 workers will be housed in an on-site construction camp for approximately 18 months during 1990 and 1991. Prefabricated buildings will be used for lodgings, mess halls, and recreational buildings.

Water required during construction will be taken using a temporary pump from the Athabasca River at the site of the proposed permanent intake location and pumped to a storage pond at the mill site. Water for camp use will be treated in a treatment plant beside the storage pond.

Solid construction wastes will be landfilled on site in a manner approved by Alberta Environment. Sanitary waste will be treated on site.

Estimated vehicle movements during the construction period are shown below.

Period	<u>Vehicles Per Day</u>	
	Cars	Trucks
July 1989 - Dec 1989	50	50
Jan 1990 - June 1990	100	200
July 1990 - Dec 1990	500	30
Jan 1991 - July 1991	600	50

Albertan and Canadian content will be emphasized as much as possible in expenditures for project management, engineering, construction, equipment and materials.

Alberta-Pacific is committed to ensuring that the local and regional environmental impacts of the pulp mill are minimized, and to this end has incorporated state-of-the-art environmental control technology in the process design. Alberta-Pacific will also initiate a range of water and air quality monitoring programs during both construction and operation of the mill and will implement additional impact mitigation measures as required (Sections 4.1, 4.2, 4.3). The results of the monitoring programs will be used to ensure that predictions of impacts made in this report are correct and will be regularly reported to Alberta Environment. The Company views Alberta Environment's role in environmental management of the mill as including the following components:

- ensuring that provincial standards are maintained;
- provision of advice in setting up monitoring programs;
- spot check confirmatory monitoring; and
- review of monitoring program results and ordering of changes if necessary.

Alberta-Pacific would also welcome the opportunity of cooperating in an overall monitoring program for the Athabasca River basin, coordinated by Alberta Environment.

Alberta-Pacific will work with a local area residents' committee to identify and manage environmental impacts and to implement mitigation measures as they apply to the local community. The Company also intends to work with a regional committee (representing such groups as regional municipalities, business groups, school boards, health units and medical authorities) throughout mill construction and operation to identify changing needs and schedules. Meetings with these committees will be held regularly. The Company fully intends to work with the regional communities and the appropriate government agencies to ensure that environmental impacts of the project are minimized and that benefits are maximized.

3.1 BASIS OF DESIGN

A major consideration in the overall environmental design of the proposed pulp mill was the selection of a site combining economic viability and engineering feasibility with minimum environmental and social impact. The site chosen has the following benefits:

- availability of land;
- compatibility of development with local land use by-law;
- within reasonable commuting distance of established communities;
- approximately equidistant between Lac La Biche and Athabasca;
- suitable terrain characteristics and engineering properties of soils on site;
- avoids using class 1, 2, or 3 agricultural soils;
- avoids disturbing sensitive habitat;
- lends itself readily to future expansion;
- accessible for rail spur development north from Boyle;
- close proximity to Athabasca River for economic supply of process water and discharge of treated effluent;
- serviced by existing county roads;
- economic haul distance for logs;
- economic distance from existing power grid;
- natural gas readily available on site; and
- dissolved oxygen impacts minimized by distance of mill site downstream from other pulp mills and by its position relative to Grand Rapids, allowing reaeration to occur between the mill and Fort McMurray.

None of the other sites investigated had as favourable a combination of advantages.

In addition to their role in the site selection process, environmental considerations were integral in the mill design and preliminary

selection of equipment. Alberta Environment requires best achievable technology to be considered in the selection of air emission and effluent control equipment for new kraft mills. Best achievable technology is here understood to mean the employment of the most modern commercially proven control equipment to minimize the impacts of air and water discharges while still ensuring that the costs of purchasing and operating the equipment do not compromise the economic viability of the project.

As designed, the mill is potentially compatible with a number of other, as yet experimental methods with potential to further improve the quality of liquid effluents and atmospheric emissions. Alberta-Pacific intends to continue to implement improved environmental control technologies as they become commercially proven.

3.2 EFFLUENT MANAGEMENT

Applications of best achievable technology to in-plant water and effluent management in the Alberta-Pacific mill are outlined below. These technologies would not be found in a conventional kraft mill.

Process	Provides reductions in			
	BOD/COD	Colour	TOCL	Dioxin
Modified continuous cooking			X	X
Steam stripping of condensate				X
Multi stage pre-bleach washing			X	X
Oxygen delignification	X	X	X	X
Multiple chemical addition			X	X
70% chlorine dioxide substitution		X	X	X
Medium consistency chlorination			X	X
Minimum economic water consumption				

Use of most of these in-plant environmental control technologies requires major additional capital costs and generally do not improve either production quality or quantity, or reduce operating costs. Hence these process options are considered to be an integral part of the environmental control and effluent management systems.

Utilized together these in-plant processes are expected to reduce the usage of elemental chlorine by 85% and the production of total organic chlorine by 80% compared to conventional mills, as well as to provide major reductions in colour, BOD, COD and the volume of wastewater flow to the external environmental control systems.

The out-of-plant effluent management system includes:

- primary and secondary treatment systems for mill effluent;
- an emergency spill pond;
- a collection system for surface runoff from wood handling areas for delivery to the effluent treatment system;
- a collection system for recycling of discharges from process upsets;
- a treated effluent foam control pond; and
- a treated effluent diffuser designed to meet the site-specific needs of the Athabasca River.

Alberta-Pacific will continue to monitor advances in process and effluent treatment methods and will implement new techniques and technologies for improving effluent quality as they become practical.

3.2.1 Effluent Sources

Three dedicated sewers - acid, alkaline and general - will direct effluents from the mill to the effluent treatment system.

The general sewer collects miscellaneous discharges as well as treated effluents from the brownstock, bleach plant and machine room areas.

These latter effluents are routed through a fibre recovery system prior to being combined with the general sewer. Alkaline effluent will be combined with the mill general sewer and routed to the primary clarifier for solids removal. Acid effluent has very low concentrations of suspended solids, and after neutralization with lime mud will be piped directly to the biological effluent treatment system. The characteristics of the three mill sewer streams are summarized in Table 3.1.

Table 3.1 Predicted characteristics of mill sewer streams

	Acid Sewer		Alkaline Sewer		General Sewer	
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood
Volume (m ³ /ADt)	11	11	15	15	26	26
Temperature (°C)	60	60	70	70	50	50
TSS (kg/ADt)	-	-	-	-	11	13
BOD (kg/ADt)	3.5	2.2	3.5	2.2	13	12
Colour (kg/ADt)	7	3	26	11	40	17
TOC1 (kg/ADt)	1.2	0.5	0.3	0.5	-	-
pH	3.5-4.0	3.5-4.0	9-10	9-10	6-8	6-8

Effluents from the digester, recovery and recausticizing areas will be collected in sumps and clarifiers and returned to process. The two major cooling water streams will pass through a cooling tower and will also be returned to process. Surplus cooling water and clean water streams will be routed either to the outlet of the secondary treatment system or to the raw water pumphouse for heat input.

Sanitary waste will be treated separately prior to discharge to the secondary biological effluent treatment system. The sanitary waste treatment plant used for the construction camp will be retained for the mill operation.

3.2.2 Effluent Treatment

Alternatives Considered

The only secondary effluent treatment systems considered for use in the Alberta-Pacific project were those that:

- use proven technology; and
- have a proven capability to successfully treat kraft mill effluents on a full scale basis to standards required by Canadian federal and provincial governments.

Two treatment systems, both of which are used following primary clarification, meet these criteria:

- aerated stabilization basins (long retention system); and
- activated sludge (high rate, short retention system).

The long retention aerated lagoon system or ASB was chosen over the high rate, short detention time activated sludge system for the following reasons:

- It is a simpler process to operate and maintain and often requires little or no nutrient addition and minimal pH control;
- The process can absorb peak daily shock loadings of concentrated mill effluent without loss of treatment efficiency;
- It generates lower quantities of sludge resulting in simpler, less expensive sludge handling equipment and reduced operational and maintenance costs;
- Aerated lagoons reduce the number and complexity of different types of mechanical equipment required in the treatment system.
- Sufficient land is available for the construction of a long retention aerated lagoon system;
- Aerated lagoons provide superior toxicity removal; and
- Properly designed aerated lagoons in Canada have demonstrated the same or better TOCl removal capabilities as the activated sludge process without the associated concerns of chlorinated sludge disposal systems.

Ultrafiltration was not considered as an option for colour removal because it is not a proven system on a full scale basis.

Alberta-Pacific is continuing to evaluate effluent treatment options in order to ensure the optimal design is selected. The currently preferred system is described below.

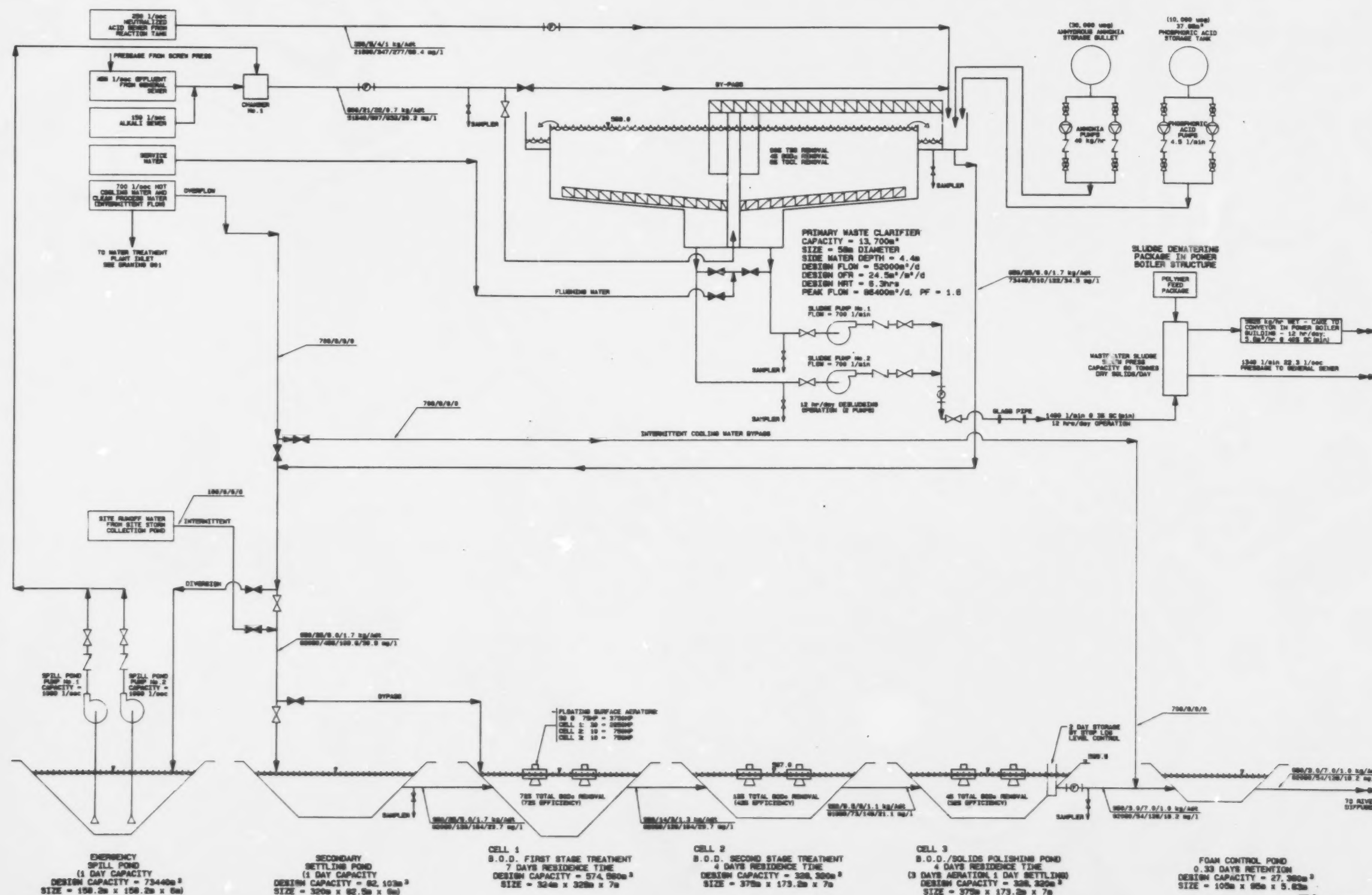
Preferred Treatment System

The effluent treatment system (Figures 3.1, 3.1a) is designed on gravity flow and will include all process effluent from various mill unit operations. All mill process effluents except the acid sewer will be treated in a primary clarifier to remove solids. The neutralized acid effluents will bypass primary clarification and join the primary clarifier effluent prior to entering the secondary biological effluent treatment system.

The mill effluent treatment system downstream of the primary clarifier will include an emergency spill pond, a secondary settling basin, and a series of three aerated cells. A bentonite enriched soil liner will be provided for all treatment ponds to prevent exfiltration. An asphalt liner will be provided for the emergency spill pond.

The secondary settling basin will have a capacity sufficient to hold 24 hours of effluent flow. There will be no aeration devices associated with this part of the system. The geometric configuration will provide for gravity settling of settleable solids throughout its length.

From the secondary settling basin, the effluent will pass through the three aerated cells. The aerated cells are designed to reduce the biochemical oxygen demand of the influent by 82%. The ponds will utilize a surface aeration system for oxygen transfer to the wastewater, providing the opportunity for active biological



NOTES

1) DESIGN LOADINGS:
FLOW, m³/d, l/sec / BODs /
TSS / TOCL, kg/Adt, mg/l

2) NORMALLY CLOSED VALVE

3) NORMALLY OPEN VALVE

LEGEND

EFFLUENT STREAM CHARACTERISTICS

FLOW l/s	BODs kg/Adt	TSS kg/Adt	TOCL kg/Adt
00/000/0.0/0.0	0 kg/Adt	0 kg/Adt	0 kg/Adt
00000/000/000.0/00.0	mg/l	mg/l	mg/l
FLOW m ³ /d ³			

Figure 3.1
EFFLUENT TREATMENT
SYSTEM FLOW SCHEMATIC

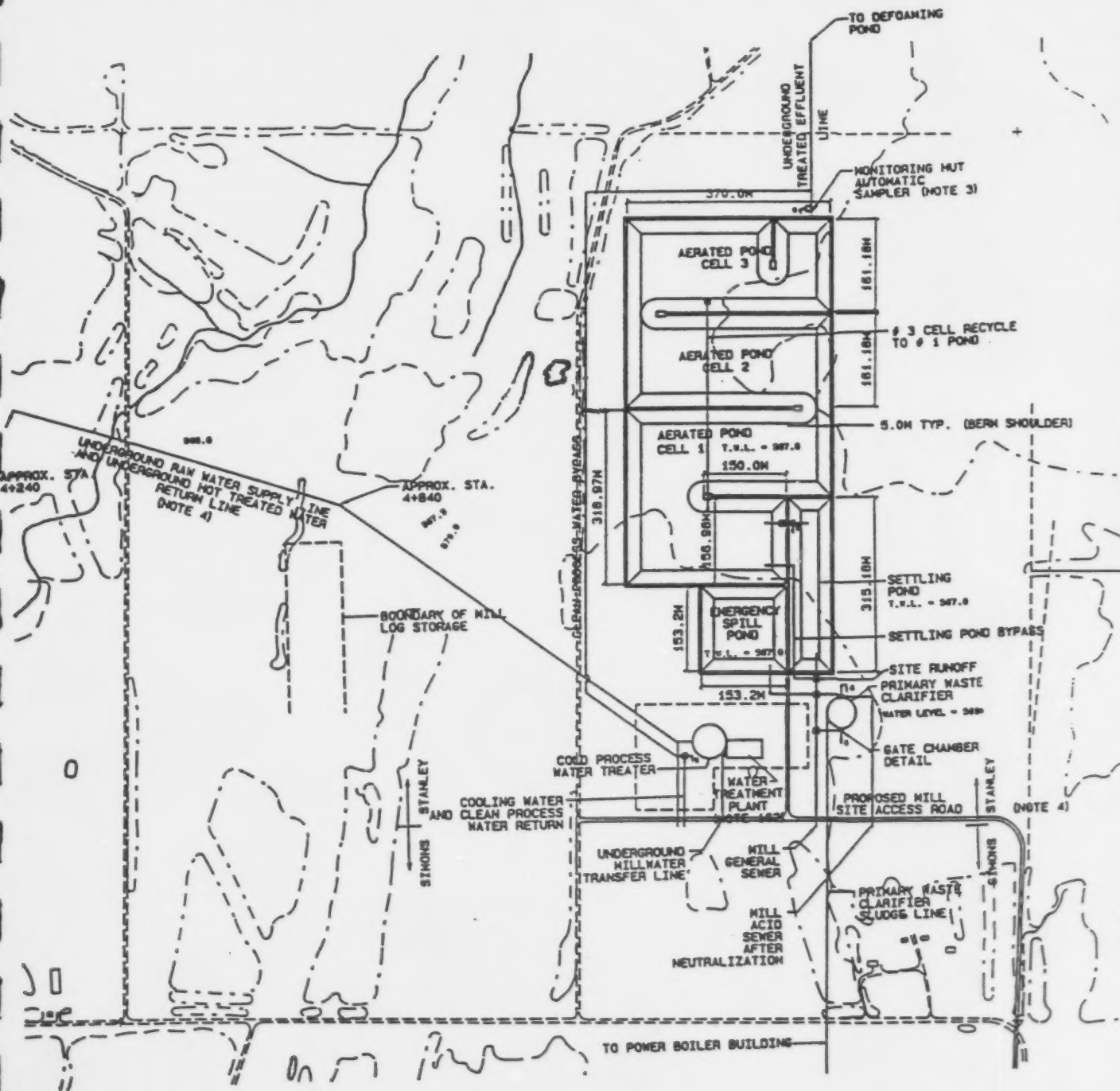


Figure 3.1A

EFFLUENT TREATMENT SYSTEM LAYOUT

decomposition of the wastewater to meet the effluent discharge requirements. The third cell will include a quiescent zone which will allow for the removal of settleable solids. Total retention time in the three aerated cells will be 15 days (Cell 1: 7 days; Cell 2: 4 days; Cell 3: 4 days).

The effluent will be sampled via a vacuum sampler contained in a sampling hut before entering the treated effluent pipeline.

The treated effluent pipeline will be 914 mm (36") inside diameter and will be designed to provide for a peak flow of 1.5 m³/s. It will be designed to operate as a surcharged gravity (free draining) pipeline. The planned pipeline alignment leads approximately 5.8 km in a northeasterly direction to the Athabasca River, staying to the south and east of the Pine Sands Natural Area (Figure 2.2).

The effluent pipeline will discharge into a foam control pond sized to retain 8 hours of flow. From this pond, it is currently proposed that treated effluent will enter a gravity-fed diffuser pipeline, from which it will be released to the Athabasca River.

The sludge from the primary clarifier will be pumped to the power house where it will be dewatered by screw press and burned in the power boiler.

In the event of a spill or process upset, mill effluents will be directed to an emergency spill pond sized to accept 24 hours of effluent. The contents of the spill pond will then be metered into the effluent treatment system at a rate that will not adversely affect the treatment process.

3.2.3 Effluent Discharge

The outfall structure will be designed to:

- accomplish mixing as rapidly as possible;

- minimize the visual impact of the effluent discharge;
- be protected from ice damage; and
- accommodate local river bed scour.

The outfall type judged to best meet these criteria at the proposed discharge site is a vertical jet diffuser. This high-velocity outfall configuration has received considerable attention in the past few years and has been found to have better mixing characteristics than low-velocity diffusers. The diffuser structure will extend approximately 25% to 30% of the distance across the Athabasca River and will comprise multiple jets discharging from a height of 0.3 to 0.8 m above the river bed. This height will be sufficient to accommodate irregularities in the bottom profile and to prevent river sediments from covering the outlets. The top of the structure will be low enough to be well below ice level. Scour protection will be provided by burying the diffuser piping to a depth of 2 m.

The Alberta-Pacific diffuser will be designed to provide a 20:1 dilution ratio within 50 m downstream of the outfall.

3.2.4 Effluent Characteristics

The estimated average characteristics of Alberta-Pacific's treated effluent, based on an annual average blended hardwood/softwood production of 1438 tonnes per day, are listed below. Treated effluent characteristics for conventional kraft mills are included for purposes of comparison.

	Alberta-Pacific		Conventional
Design flow	0.95 m ³ /s		
Peak flow	1.5 m ³ /s		
pH	6 - 8		6 - 8
COD	8 kg/ADt		15-18 kg/ADt
BOD	3 kg/ADt	53 mg/L	5-9 kg/ADt
Suspended solids (TSS)	7 kg/ADt	120 mg/L	7-10 kg/ADt
Colour	43 kg/ADt	750 units	120-170 kg/ADt

TOC1	1.0 kg/ADt	18 mg/L	5-11 kg/ADt
Temperature	250C max.		
Dioxin/furan	non-detectable (less than 0.01 ppt)		0.1 ppt

These figures represent treatment efficiencies of 88% for BOD, 73% for TSS and 40% for TOC1.

The maximum daily discharges for BOD, COD, colour and TOC1 are estimated to be 1.5 times the annual average; the estimated maximum daily discharge of TSS is twice the annual average.

3.2.5 Effluent Monitoring

A comprehensive effluent monitoring program will be implemented in order to ensure that the effluent is non-toxic and that it meets the specifications of the water licence with regard to biological oxygen demand and other water quality parameters. Details of the monitoring program are provided in Section 4.1.7.

3.3 AIR EMISSIONS

In order to apply best achievable technology to air emissions, the Alberta-Pacific pulp mill will incorporate the following equipment and technologies:

- optimized stationary firing system for the recovery boiler to minimize sulphur dioxide emissions;
- a modern low odour recovery boiler together with black liquor evaporators equipped with concentrators to minimize total reduced sulphur (TRS) emissions;
- high efficiency electrostatic precipitators for particulate sources;

- bleach and chemical plant emission scrubbers;
- stripping of contaminated condensates;
- collection and incineration of gases from both LVHC and HVLC odour sources to minimize fugitive emissions; and
- computer aided control systems.

3.3.1 Emission Sources and Characteristics

The principal sources of atmospheric emissions from the mill will be the recovery boiler, power boiler, and lime kiln. The major types of emissions expected from these and other mill sources are shown below:

	SO ₂	H ₂ S	NO _x	Cl ₂	ClO ₂	Odour	Water Partic- Vapour ulates
recovery boiler	X	X	X			X	X
power boiler	X		X				X
lime kiln	X	X	X			X	X
smelt tank		X					X
slaker scrubber		X					X
bleach plant				X	X		
chemical preparation				X	X		X
effluent treatment system						X	X

Table 3.2 gives the maximum expected emissions during normal operations for the main atmospheric emission sources. Table 3.2 is based on an average 1250 ADt/d softwood pulp production, which will result in higher emission rates than the 1500 ADt/d hardwood operating mode.

The lime kiln and recovery boiler emissions include the combustion products of the low volume, high concentration (LVHC) and high volume, low concentration (HVLC) vent streams, respectively. These vent

Table 3.2 Expected maximum atmospheric emissions during normal operations

Stack	Flow		Moist. (%)	Temp		H ₂ S		SO ₂		NO _x		CL ₂		ClO ₂		Partic.
	(m ³ /s)	(g)		(°C)	ppm	kg/d	ppm	kg/d	ppm	kg/d	ppm	kg/d	ppm	kg/d	mg/m ³	
Recovery boiler	93.3	26	195	6.5	80	600	13840	50	830	-	-	-	-	-	-	90 726
Power boiler	83.3	24	170	-	-	50	1030	80	1180	-	-	-	-	-	-	240 1730
Lime kiln	11.5	25	180	10.0	15	30	85	100	204	-	-	-	-	-	-	130 129
Smelt tank	14.3	44	85	22.3	42	-	-	-	-	-	-	-	-	-	-	215 266
Slaker scrubber	3.9	90	90	13.7	7	-	-	-	-	-	-	-	-	-	-	135 46
Bleach plant	2.5	80	75	-	-	-	-	-	-	32	22	108	65	-	-	-
Chemical prep.	3.3	35	20	-	-	-	-	-	-	18	16	43	35	75	22	22
Totals						144	14955	2214	38	100	2919					

streams, which together comprise the non-condensable gas (NCG) system, include emissions from the following sources:

LVHC	HVLC
digester relief condenser	digester chip bin
turpentine handling well	blow tank
evaporator hot well	fibre filter feed tank
stripper feed tank	screening rejects tank
stripper overheads	decker and filtrate tank
	brownstock washer and filtrate tank
	weak black liquor storage tank
	strong black liquor storage tank
	precipitator mix tank
	chemical ash mix tank

The LVHC and HVLC systems will be designed to deal with the four properties of non-condensable gases that are of concern: i.e. the gases are toxic, corrosive, explosive when mixed with air, and malodorous. The gases that must be collected by the NCG system are hydrogen sulphide (H_2S), methyl mercaptan (CH_3SH), dimethyl sulphide (CH_3SCH_3) and dimethyl disulphide (CH_3SSCH_3). These gases are known collectively as total reduced sulphur (TRS). Other gases such as turpentine and methanol are also present in the NCG gas streams.

The LVHC gases will be incinerated in the lime kiln with power boiler backup, while HVLC gases will be incinerated in the recovery boiler. Exhaust during emergency conditions for both systems will be via the recovery boiler stack in vents provided.

3.3.2 Air Emission Controls

The air emission control equipment will be designed to achieve compliance with all current Alberta Environment regulations governing this type of plant.

High concentration, low volume malodourous gases will be collected and, where required, scrubbed or treated prior to incineration in the recovery boiler. Low concentration, high volume sources will be collected and conveyed to the lime kiln for incineration. The digester flash steam will be condensed and the condensates transferred to the steam stripping system. Chemical storage tank vents, the chlorine stage tower vent, chlorine dioxide stage tower vents and washer exhausts will be scrubbed prior to release to atmosphere.

Particulate emissions will be controlled at each source by high efficiency collection equipment such as electrostatic precipitators, scrubbers and mechanical collectors.

3.3.3 Air Emission Monitoring

A monitoring program designed to provide background information on local (on-site) ambient air quality and meteorological conditions will be initiated prior to mill construction. The following air quality parameters will be monitored on a continuous basis:

- hydrogen sulphide
- sulphur dioxide
- total hydrocarbons
- oxides of nitrogen.

The following meteorological parameters will also be continuously monitored:

- wind speed
- wind direction
- temperature.

The monitoring program is scheduled for two to three months with a target start date of June 1, 1989; the extent of monitoring beyond this period will be determined after detailed review of the initial data.

During mill operation, gaseous emissions will be monitored in accordance with Alberta Environment requirements. Ambient air quality will be monitored for SO₂ and H₂S using a monitoring trailer. The trailer will also be equipped to automatically record wind speed and direction. Stack emissions will be monitored to ensure compliance with permit requirements. Local meteorological conditions will be monitored at an on-site station.

3.4 SOLID WASTE MANAGEMENT

3.4.1 Construction Phase

During construction of the mill, waste materials will consist mainly of spoils from site grading. These will be lightly compacted, graded in spoil disposal areas, and revegetated if necessary to prevent silting of watercourses. Other solid wastes will consist of construction debris and putrescible waste from the kitchens and construction camp. The putrescible waste will be disposed of on site in a separate landfill approved by Alberta Environment. The construction debris will be disposed of on site, either by incineration or burial, in a manner approved by Alberta Environment.

3.4.2 Operation Phase

During the operation of the mill, a variety of solid wastes will be generated. Each waste will be disposed of using techniques appropriate to its characteristics, either landfilling or incineration to provide power. Landfilled wastes will be directed either to a Class II or a Class III industrial landfill, as appropriate. Putrescible wastes will be landfilled separately. On-site location of landfill operations is planned, pending the results of geotechnical investigations that are currently in progress; should on-site landfilling prove impractical, however, a nearby off-site location with more suitable characteristics

will be selected. Wherever the landfill sites are located, they will be designed to meet Alberta Environment requirements.

Any hazardous wastes generated during mill operation (e.g. empty chemical drums) will be handled using methods approved by the Alberta Special Waste Management Corporation, and eventually transported, if required, to Swan Hills for disposal.

Continuous Waste Streams

The sources, amounts and disposal methods for continuous mill waste streams are summarized in Table 3.3.

Table 3.3 Continuous waste stream characteristics.

Stream	Amount - ADt/a	Disposal Method
Wood yard waste	9,000 - 18,000	Incineration
Sludge from primary clarifier	5,000 - 10,000	Incineration
Ash from power boiler	9,000 - 15,000	Landfill
Dregs and grits from green liquor filter and slaker	9,000	Landfill
Screen rejects from brown stock screening	2,000 - 6,000	Incineration
Cleaner rejects	500 - 700	Landfill

Wood wastes (bark, waste wood and chip fines) will normally be burned in the power boiler. Only wood yard waste unsuitable as hog fuel will be sent to the landfill.

The sludge from the primary clarifier will normally be mixed with the wood waste and burned in the power boiler. It is anticipated that no sludge will be sent to landfill during normal operation.

The ash from the power boiler will be sent to landfill. The type of ash handling will be determined during the detailed engineering phase of the project.

The dregs from the green liquor filter and the dregs and grits from the slaker will be combined in a common area and trucked to the landfill site.

The screen rejects from the brownstock screening system will be dewatered in a drainer and generally sent to the hog fuel boiler.

The bleached pulp screening and cleaning rejects will be dewatered in a fibre recovery unit and sent to landfill.

Intermittent Waste Streams

Intermittent waste streams, which are generated on a periodic basis, may be related to normal mill operation, to mill maintenance or to infrequent process upsets. They include:

- knotter rejects,
- process debris trap reject material,
- digester and evaporator acid wash waste material,
- heat exchanger and tank wash waste material,
- mill process water treatment chemical waste,
- boiler feed water treatment chemical waste,
- contaminated pulp, and
- raw water softener sludge.

The knotter rejects will normally be returned to the digester plant for re-cooking, but should this become impossible due to temporary process

or equipment upsets, this stream may have to be sent to landfill. The maximum amount of such knotted rejects is estimated to be 100 t/d.

The pulping process is protected by debris traps in several areas. Sand, rocks, metal, plastic and other unwanted material collected at these traps will be sent to landfill. The amount of debris varies with season and general housekeeping standards, and could be in excess of 5 t/d.

The digester and evaporator systems require frequent cleaning to remove scale and other deposits within the system. The systems are periodically washed with acid during mill shutdowns. The waste acid will be neutralized if required, and sewerage.

Heat exchangers and tanks prone to scaling will be washed and de-scaled during normal operation and the waste acid will be neutralized if required, and sewerage.

Other miscellaneous waste which will be sent to landfill includes wastes from shops and stores and normal waste from the mill material handling facilities. Oil and lubricants will normally be sent to specialized treatment and handling facilities.

Inadequate quality pulp (unbleached and bleached) resulting during upset operating conditions may have to be sent to landfill.

Raw water softener sludge, which consists mainly of sediment removed from the raw water supply along with some lime and other water softening chemicals, will be dewatered and sent to landfill.

3.5 NOISE CONTROL

Noise levels will be controlled at source. The general criteria will be based on the Alberta Occupational Safety and Health guidelines and

regulations. Selected equipment will be installed in specially designed enclosures to reduce the ambient noise to an acceptable level. The equipment requiring special enclosures and/or silencers will be identified during the detailed engineering phase of the project.

3.6 SURFACE RUNOFF

3.6.1 Rain Storm Events

Two independent surface drainage systems, both designed for the 10 year return period storm event, will drain storm and snowmelt water from the mill site (Figure 3.2). Drainage from the east half of the site will be collected by road and site ditches, culverts and pipelines, including roof drainage collection systems, and conducted to a storm drainage sedimentation pond in the northeast portion of the site. This water, which will generally be of high quality, will then normally flow into the natural drainage system of the surrounding land. The design storm flow for this drainage system is 570 L/s. Monitoring of the runoff will be carried out to ensure quality is adequate before discharge to the environment. Provision for low quality water in the storm drainage pond has been made by means of an emergency bypass to the effluent treatment system.

The remainder of the site runoff (design stormflow 140 L/s) will be conducted to a grit and silt collection pond and then to the effluent treatment system, and will ultimately flow into the Athabasca River as treated effluent. Runoff from the following areas will follow this route:

- hog fuel, chip storage and chip handling areas
- woodroom area and building
- log storage and operations.

Soils in these areas will be treated with soil cement to minimize infiltration of surface runoff and snowmelt.

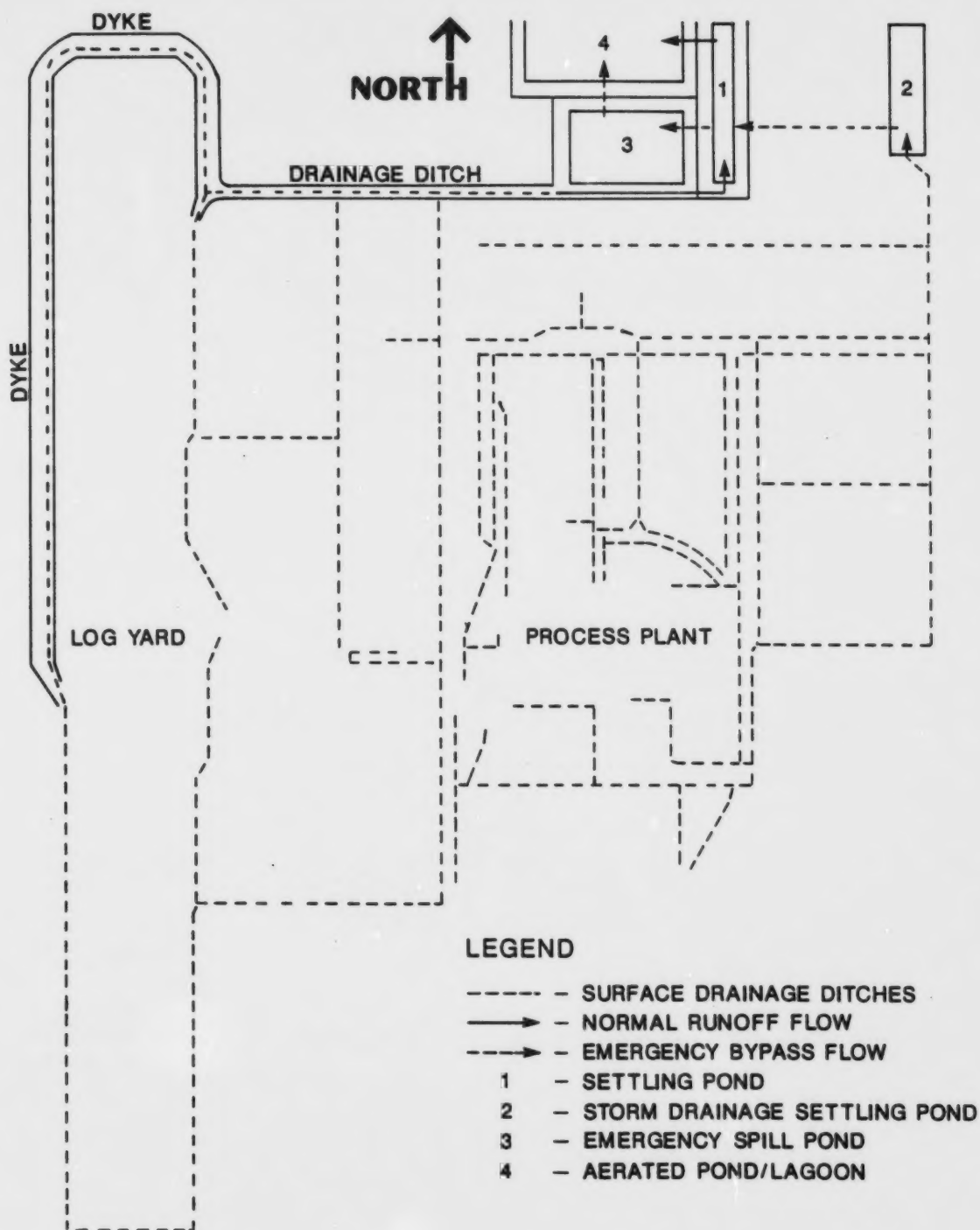


Figure 3.2

**SURFACE RUNOFF
DRAINAGE SYSTEM**



Detailed design of the storm drainage and surface runoff handling system is in progress.

3.6.2 Spills

Possible spills within the fibreline, which includes the brown stock washing area, the oxygen delignification area, and the bleach plant, are primarily water, stock, and weak black liquor. All elevated floors in these areas will be equipped with floor drains leading down to trenches in the ground floor. The ground floor trenches will be equipped with floor sumps to provide surge capacity in the event of a major spill. The trenches and the sumps will be separated so that liquor contaminated stock can be collected in a dedicated collection system. Clean or bleached pulp fibre and/or water will drain to its own system. Both systems will be equipped with emergency sump pumps that will allow a diversion of spills from the pulping line sewers back into the process. The black liquor recovery system will be controlled by conductivity sensors and alarms to ensure minimum liquor losses. Any spills from tanks placed outside buildings will be contained by curbs and routed to the general fibreline trench and sewer systems.

The black liquor recovery system at the evaporator and chemical recovery areas will be similar to the system in the digester and brown stock areas, including a dedicated spill tank for containment and storage of spilled liquor prior to mixing with the normal feed to the evaporators.

The lime mud recovery system at the recausticizing and lime reburning areas will include a spill clarifier equipped with a rake assembly. Any spill and normal floor trench streams will be collected in adequately sized sumps and pumped to the spill clarifier. The clarifier overflow will be diverted to the general sewer and the clarifier underflow will be returned to process.

All chemical storage tanks located in the chemical unloading and storage building complex will be placed in curbed and drained areas to segregate the various chemicals and to route possible spills or leaks to the mill sewers. The trench systems will be supplied with gas tight sealed pumps. The chlorine dioxide plant will be equipped with its own system of floor drains and trenches and will also be provided with separate sumps for discharge to the mill sewers.

The flammable liquids stored on site will be turpentine (a process by-product) and methanol. Both chemicals will be stored in tanks located inside concrete compounds designed to contain the total content of the tanks. Should a spill occur in this area, liquids will be removed by pumping, as there will be no drainage facilities to the area outside the compounds.

In addition to the above controls, the following sources will be monitored for potential black liquor or chemical carry-over of spills:

- evaporator condenser,
- turpentine condenser,
- cold blow cooler,
- chlorine dioxide plant condenser,
- black liquor filtrate cooler,
- black liquor cooler,
- green liquor cooler, and
- flash steam condenser.

Cooling water streams from these sources will be monitored by on-line conductivity sensors. If the conductivity exceeds a design value, then the cooling water will be diverted to the general sewer and effluent treatment facilities.

Out-plant spill controls include an emergency spill basin designed to hold up to 24 hours of total mill effluent. The spill pond will serve two primary functions:

- containment of any emergency process and chemical spills that may occur in the plant; and
- flow equalization and feeding major diversions of contaminated cooling water to the aerated lagoon at a controlled rate.

The emergency spill basin will also be designed to contain surface runoff or snowmelt that has been contaminated by spills. Contaminated runoff will be channelled to the pond via bypasses from the effluent treatment system settling pond and the storm drainage settling pond.

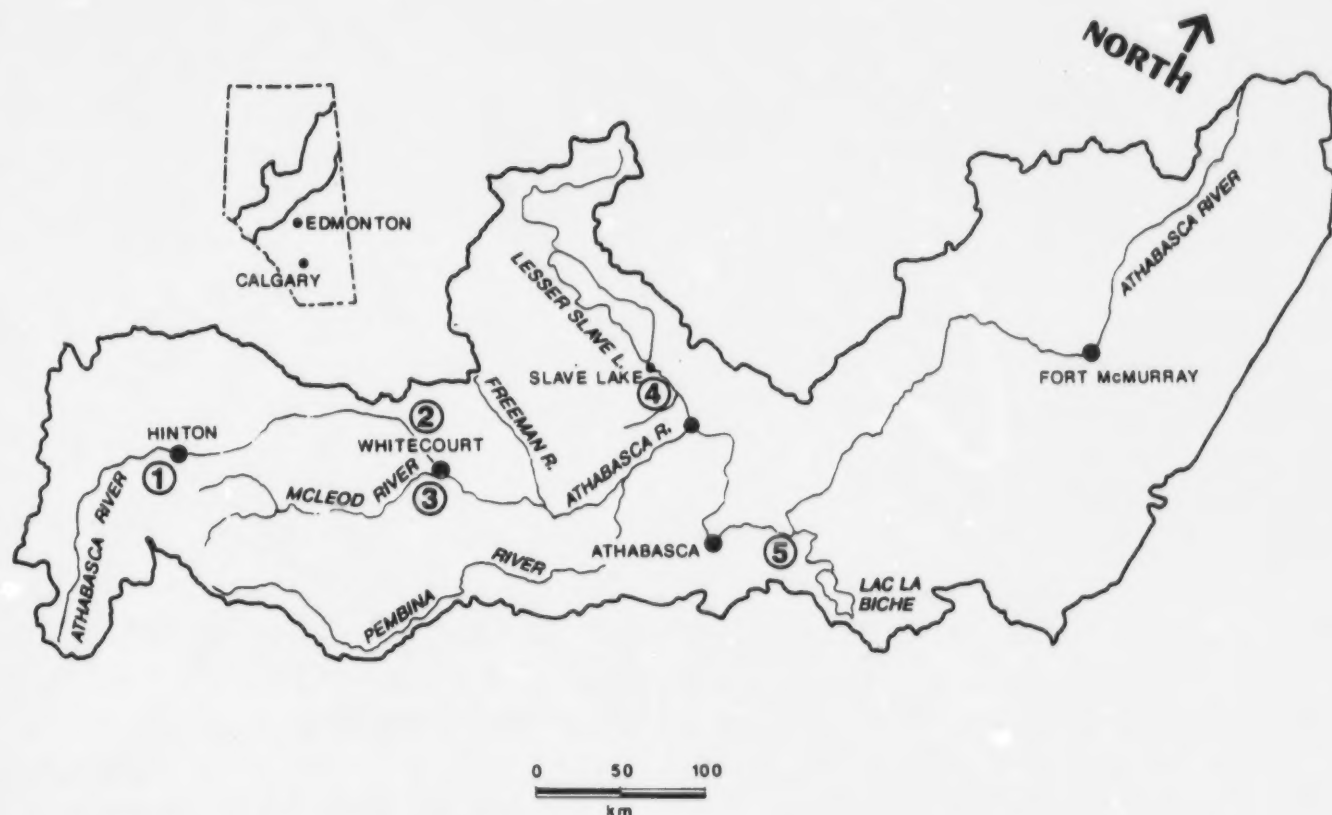
4.0 ENVIRONMENTAL IMPACTS

4.1 AQUATIC IMPACTS

4.1.1 Introduction

As a result of initial environmental studies and discussions with Alberta Environment, it was determined that perhaps the most important aquatic issue arising from the Alberta-Pacific Forest Industries mill was the potential effect of BOD within treated effluent on dissolved oxygen concentrations in the Athabasca River, particularly in view of current and potential pulp mill developments elsewhere in the basin (Figure 4.1). The dissolved oxygen aspect accordingly received considerable attention during preparation of the impact assessment document.

During meetings with the general public, however, it was evident that several other issues were potentially of even higher local concern. The impacts of chlorine and chlorinated organics in general, and dioxins in particular, were clearly of very significant concern, particularly in downstream communities such as Fort McMurray. Effluent toxicity and concerns regarding tainting were also raised on numerous occasions, particularly by local sportsmen. Area residents appeared to be particularly worried about the risks of contamination of both local surface water (from site runoff) and groundwater (from landfill leachates and lagoon leakage). Water usage, primarily during low flow conditions, was also raised as an issue by members of the public. Wherever possible, these public issues have also been addressed in the EIA. Additional topics of importance addressed include: suspended solids loadings, colour, impacts on fisheries resources, impacts on downstream water uses, and potential groundwater impacts. Details of the aquatic impact assessment are presented in Appendix 1 of this report.



- ① WELDWOOD FOREST PRODUCTS (ALBERTA) LTD.
- ② ALBERTA NEWSPRINT COMPANY LTD.
- ③ MILLAR WESTERN PULP LTD.
- ④ ALBERTA ENERGY COMPANY LTD.
- ⑤ ALBERTA-PACIFIC FOREST INDUSTRIES INC.

Figure 4.1

ATHABASCA RIVER BASIN

4.1.2 Existing Surface Water Quantity and Quality

The main waterbody that will be affected by the proposed pulp mill is the Athabasca River, a relatively large river with a mean annual flow, near the mill site, of 436 m³/s. The lowest flows normally occur during the period December through March. Discharge increases sharply in April toward a June/July peak, and then decreases gradually toward the low flow period. The minimum and maximum recorded discharges are 42.2 and 5440 m³/s. The river is normally frozen over between late October and mid April.

Two very small, intermittent watercourses, known locally as Deer Creek and Bear Creek, drain generally northeast to the Athabasca River in the vicinity of the mill site, one to the west of the mill and one to the east. No historical information is available on flows in these watercourses, but baseline data are currently being collected by Alberta-Pacific.

The portion of the Athabasca River near the mill site lies within the intermediate of three water quality zones in the Athabasca Basin defined by Hamilton et al. (1985). In this zone, water quality characteristics change from foothills typology to that of the lower basin because of tributary inputs. Alkalinity and hardness levels decrease while concentrations of suspended solids, metals, nutrients and carbon increase. Water quality varies seasonally, with sediment and runoff related particulate parameters occurring in the highest concentrations during the peak runoff period, and major ion and carbon concentrations being maximal during the fall and winter low flow period. No historical information is presently available on water quality within the small watercourses close to the mill site, but background studies have been initiated.

4.1.3 Impacts on Surface Water Quantity and Quality

4.1.3.1 Water Quantity

All water used in the mill will be obtained from the Athabasca River. Peak water withdrawals will be $1.55 \text{ m}^3/\text{s}$. Since approximately 90% of water withdrawn will be returned to the river, the maximum water consumption of the mill will be $0.15 \text{ m}^3/\text{s}$, which is only 0.37% of the lowest recorded river flow. The effects of the mill on water quantity will thus be extremely small at all times.

Concern was raised on several occasions by area farmers regarding impacts of the mill on local watercourses, which are used as a water source for cattle. Once the mill is in operation, the total volume of water entering local watercourses from the mill site will likely be somewhat reduced overall, although peak runoff may be increased. It is not known whether overall water yield in these watercourses will be significantly affected; however, since the mill site represents only a small portion of their drainage basin areas, potential changes are expected to be small. The risk of flooding due to high volumes of stormwater or snowmelt runoff from the mill site will be minimized by controlling the rate of outflow from the storm drainage settling pond (Section 3.6.1).

4.1.3.2 Dissolved Oxygen

The biochemical oxygen demand (BOD) of kraft mill effluents is of potential concern because of its influence on dissolved oxygen (DO) concentrations in receiving waters. BOD of these effluents is high due to the large amounts of wood sugars and other organic material in the effluent. These food sources stimulate the growth of naturally occurring organisms in the river, leading in turn to

high levels of oxygen use and therefore potentially low DO levels. Low DO levels in turn can affect the basic ecology of a river, including fisheries, a concern that was voiced by local sportsmen. Dissolved oxygen concentrations in the Athabasca River near the mill are of concern only during low flow events under ice cover, when reaeration is limited. During the remainder of the year, natural reaeration maintains DO at safe levels.

The effects of Alberta-Pacific's expected effluent discharges on dissolved oxygen concentrations were simulated along a 350 km length of the Athabasca River extending downstream from the mill site to the vicinity of Fort McMurray. The simulation was done using an Alberta Environment-approved computer model incorporating both theoretical considerations and field measurements obtained during several winter studies, the most recent being in 1989. The computer model takes into account:

- the effects of all present and potential future pulp mills discharging into the Athabasca River at full current licence limits;
- the effects of tributary stream inflows; and
- the reaeration effects of rapids within the river.

The results of the computer modelling indicated that under any reasonable low flow scenario, dissolved oxygen concentrations will remain safely above the Alberta Environment objective of 5.0 mg/L during normal mill operating conditions. In the most critical scenario modelled, which involved the 7Q10 flow (i.e. the lowest flow event of 7 days duration that occurs on average once every 10 years) maximum permitted BOD loadings from the 4 mills upstream of Alberta-Pacific, and a contribution from Alberta-Pacific of 5 kg/ADt of BOD, dissolved oxygen concentrations fell to no lower than 5.1 mg/L upstream of the Alberta-Pacific mill and 5.5 mg/L downstream. In a scenario that was identical except that the

Alberta-Pacific loading of BOD was set at the anticipated discharge limit of 3 kg/ADt, the minimum downstream dissolved oxygen concentration was 6.0 mg/L. Since the 5.0 mg/L DO criteria already has a significant safety margin, the modelling results indicated that even with all mills operating at capacity, the Alberta-Pacific operation would not endanger aquatic life due to reduced oxygen levels.

Dissolved oxygen concentrations will be monitored in the Athabasca River during mill construction and operation, as well as in treated effluent. The data can be used to further refine the model and to ensure the model assumptions used were correct.

4.1.3.3 Suspended Solids

The average total suspended solids (TSS) concentration in the mill effluent is expected to be about 120 mg/L. Suspended solids in biologically treated kraft effluents tend to consist of a variable combination of wood fibres and biosolids from the treatment lagoon (i.e. the bodies of the microbes which break down the other effluent materials). Dilution will reduce this concentration to 6 mg/L within 50 m of the diffuser outfall, a concentration that will meet water quality objectives for TSS even under the most extreme low flow conditions. Mill contributions of TSS to the river following final dilution at Fort McMurray are shown below for various river flows.

	TSS (mg/L)	
	River Background	Effluent Contribution
Monthly mean flows:		
January	1.6	0.9
February	2.9	1.0
May	70.5	0.14
July	247	0.09
September	40.7	0.18
Mean annual flow:	63.6	0.22
7Q10	-	1.5

These very low additions of suspended solids to the Athabasca River are functionally almost too small to measure and are not expected to materially affect regional water quality. Some debate is still underway regarding the relative importance of solids control in order to achieve control of chlorinated organic compounds. The data on this question remain limited, and since Alberta-Pacific intends to independently monitor chlorinated organics, is not a source of concern.

TSS concentrations will be monitored in treated effluent and in the Athabasca River during mill construction and operation.

4.1.3.4 Colour

The colour impacts of the mill on the Athabasca River will be minimized by the incorporation in the mill process of oxygen delignification and high chlorine dioxide substitution. Some colour removal will also occur during effluent treatment.

Effluent emissions from the mill are expected to average 750 colour units. The corresponding colour increases that could be expected to occur at Fort McMurray at various river flows are shown below.

Flow	Colour Increase (Units)
Mean Monthly flows:	
February	6.0
May	0.8
July	0.5
September	1.1
Annual Mean	1.3
7Q10	10.0

By comparison, apparent colour in the Athabasca River naturally averages about 20 units and reaches a maximum of 160 units under ice cover. The corresponding figures for the open water season are in the order of 60 and 200 units.

Colour is of concern primarily for aesthetic reasons. During winter, the dilution factor in the river is low enough that some change in colour may be detectable in the open water area downstream of the outfall. During open water, colour discharges will be well within the natural variability of the river and should not be detectable except during low, clear flow periods and within a limited distance of the outfall.

Colour levels will be monitored in the Athabasca River during mill construction and operation, as well as in mill effluent.

4.1.3.5 Chlorinated Organic Compounds

The risks associated with chlorine and chlorine discharge were clearly of significant public concern and were raised in virtually every meeting held between Alberta-Pacific personnel and area communities.

The organochlorine content of kraft mill effluents is an important issue because of concerns relating to bioaccumulation, persistence in the environment, toxicity, fish flesh tainting, and human health risks from ingestion through drinking water. In Canada chlorinated organic compounds are normally measured as total organic chlorine (TOCl); in Europe, they are now usually measured as adsorbable organic halides (AOX). The AOX method measures more organically bound chlorine than the TOCl and is now becoming increasingly accepted in North America; however, TOCl measurements are used in this report, reflecting available data. The ratio of AOX to TOCl is variable but tends to be about 1.3 for treated effluents from aerated lagoons.

The concentration of TOCl in kraft mill effluents appears to be a linear function of the total consumption of elemental chlorine in the bleaching process. It has been determined that by incorporating the most recent modifications in bleaching to minimize chlorine use, a TOCl discharge level after secondary biological treatment of 1 kg/ADt of pulp, as measured on an annual average basis, is achievable (Axegaard 1988; Cook 1988, 1989). The Alberta-Pacific mill will incorporate the following techniques in order to meet this objective:

- modified continuous cooking
- multi-stage prebleach washing
- oxygen delignification
- multiple chemical addition
- medium consistency chlorination
- 70% chlorine dioxide substitution.

The expected TOCl emission rate of 1 kg/ADt from the Alberta-Pacific mill compares favourably with the TOCl production rates of 1.5 to 11 kg/ADt that are typical of existing kraft mills. The effluent concentration of TOCl will average 17.5 mg/L, and this

will be reduced by dilution to less than 1 mg/L within 50 m of the diffuser. The TOC1 concentrations resulting from Alberta-Pacific effluent releases that would occur at Fort McMurray, under the worst case assumption that no TOC1 would be lost to adsorption, volatilization, or degradation en route, are shown below for various river flows (units are mg/L).

Jan	Mar	Mean Monthly Flows				Annual Average	7Q10
		May	July	Sep	Nov		
0.19	0.20	0.03	0.02	0.04	0.09	0.03	0.31

The above estimates are undoubtedly significantly higher than levels that will actually occur since further decay of TOC1, even under ice, is likely. In addition, biological treatment of kraft mill effluents has been shown to greatly reduce effluent toxicity, primarily by removing the lower weight, more toxic chlorinated compounds, leaving the remaining TOC1 proportionately less toxic than for untreated effluent. Given the extensive use of both in-plant process control (Scandinavian technology) and a very effective secondary effluent treatment system (North American technology), there is no reason to suspect that TOC1 levels in the Alberta-Pacific effluents will have a negative impact on the Athabasca River water quality. This prediction appears to be supported by regulatory agencies in Sweden which have recently suggested that a level of 1.5 kg/ADt TOC1 (to be achieved by 1992) is an acceptable goal for all bleached kraft mill effluents.

The concentration of chlorinated organic compounds in the mill effluents will be monitored immediately prior to discharge to the Athabasca River. TOC1 concentrations in the Athabasca River will

be monitored prior to and during mill operation. Alberta-Pacific is also actively engaged in research to further lower and perhaps eliminate chlorine usage eventually.

4.1.3.6 Dioxins

It has recently been determined that kraft mill effluents contain extremely low concentrations of chlorinated dioxin and furan compounds, particularly 2,3,7,8-tetrachlorodibenzodioxin (or 2378-TCDD) and 2,3,7,8-tetrachlorodibenzofuran (or 2378-TCDF). 2378-TCDD is the most toxic dioxin compound, and 2378-TCDF is about one-tenth as toxic. A typical concentration of chlorinated dioxins/furans in effluents from existing kraft mills appears to be in the order of 0.1 parts per trillion (ppt).

The major mechanism by which dioxins and furans are produced in kraft pulp mills appears to be the chlorination of precursor compounds that enter the bleach plant. These precursors may come from defoamer products, process water, or the wood furnish itself (Berry et al. 1989, Kringstad et al. 1988). Dioxin and furan production rises sharply with increases in the chlorine multiple, a measure of the percent elemental chlorine used per tonne of pulp (Berry et al. 1989, de Sousa et al. 1989), as shown below.

Chlorine multiple	2378-TCDF production (ppt)
0.10	non-detectable
0.15	4
0.20	12
0.25	45

The chlorine multiple can be reduced by modified continuous cooking, high chlorine dioxide substitution, oxygen delignification, and medium rather than low consistency chlorination. Alberta-Pacific's mill will achieve a chlorine multiple of 0.06. By means of these and other process modifications, it is therefore now possible to reduce dioxin emissions to below the current threshold of detection, which is in the order of 0.01 parts per trillion. The Alberta-Pacific mill will incorporate the following features to ensure that dioxin emissions remain below this threshold:

- modified continuous cooking;
- extensive brownstock washing to minimize carryover of precursors;
- steam stripping of contaminated condensate that is to be reused in the process;
- post-oxygen delignification washing;
- oxygen delignification;
- medium density chlorination;
- multiple chemical addition in the first bleaching stage;
- 70% chlorine dioxide substitution; and
- use of dioxin precursor-free defoamers.

Public concern about dioxins, furans and other as yet unknown toxic compounds is currently at an extremely high level, and was one of the most common issues raised in both local and downstream community meetings. Since dioxin is also produced as accidental byproducts of a number of other industrial processes and through incineration of municipal wastes, it has received a significant amount of scientific attention on its toxicity, potential as a carcinogen, pathways by which it can enter the environment, and fate once it enters humans and other animals. Of particular concern has been the ability of dioxin to bioaccumulate (i.e. achieve levels much higher than the surrounding environment) in

fish. These relatively high tissue levels do not appear to affect the health of the fish, and therefore could potentially be ingested by humans. At the present time, this appears to be the only pathway by which significant dioxin concentrations could potentially develop in the local and regional environment as a result of Alberta-Pacific's operations.

Health and Welfare Canada has examined human health risks associated with dioxins and furans. Based on their findings, a level of 20 ppt 2378 TCDD, the most toxic dioxin, in fish flesh was subsequently set as the level judged to be acceptable for human consumption. More recently, a survey of 75 fish samples collected from rivers receiving effluents from pulp and paper mills in B.C., Alberta, Saskatchewan and New Brunswick revealed either no detectable levels (34 samples) or levels generally well below the 20 ppt guideline (41 samples).

No models currently exist to adequately evaluate the potential for dioxin uptake in fish at the extremely low discharge levels expected at the Alberta-Pacific pulp mill. However, it is clear that at the mills already evaluated, including the bleached kraft mill at Hinton which has been operating for almost 30 years, dioxin concentrations in tissue are not at levels considered to be a health hazard. It is reasonable to assume that many, if not all of the mills examined will, because of their older technology, have been discharging dioxins at both per tonne production and total levels much higher than will be produced by the Alberta-Pacific mill. Since dioxin levels in fish downstream of these mills are all below national requirements, it is also reasonable to assume that dioxin uptake in fish below the Alberta-Pacific mill will not become a concern.

In view of public concerns about dioxin releases to the environment, Alberta-Pacific will cooperate with Alberta Environment in implementing a monitoring program to be continued long enough to ensure that harmful quantities of dioxin do not enter or accumulate in the Athabasca River as a result of Alberta-Pacific's operations. The program is anticipated to include:

- monitoring of dioxin concentrations in mill effluent;
- measurement of baseline (ie. pre-operation) dioxin concentrations in an edible fish species (e.g. walleye) in the vicinity of the mill; and
- monitoring of dioxin concentrations in edible fish in the vicinity of the mill once operations commence.

4.1.3.7 Bacteria

Pulp mill effluents commonly contain bacteria of the genus Klebsiella which show a positive response in both the standard total and fecal coliform tests and local health units in Athabasca and Fort McMurray had previously been concerned about the human health implications of the bacteria. No data linking waterborne Klebsiella and human disease have ever been presented, however, and in a recent study of the health significance of Klebsiella in the environment, Duncan (1988) concluded that the presence of Klebsiella in lakes and streams does not produce human disease.

Site sewage, including construction camp sewage, will be treated and then routed through the effluent treatment system. The coliform bacteria removal efficiency of this double treatment is expected to be in excess of 99.9% and therefore no downstream coliform-related impacts are expected.

The effluent and Athabasca River water quality monitoring programs will include coliform bacteria.

4.1.3.8 Off-Flavours in Fish

Untreated bleached kraft mill effluents are known to cause off-flavours ("tainting") in fish. Some treated effluents are also suspected of having the potential to do so, but no such cases have been conclusively documented. The low concentration of chlorinated organic compounds (some of which are suspected of causing fish tainting) that will be achieved in the mill effluent and the large dilution capability of the Athabasca River suggest that the operation of the mill is unlikely to cause changes in the flavour of fish. Such changes, if they were to occur, would likely be transitory, disappearing shortly after the fish moved out of the effluent plume.

4.1.3.9 Nutrients

The mill effluent will contain both nitrogen and phosphorus. Of these, phosphorus is of more potential concern because it is normally the nutrient that limits primary productivity (i.e. plant growth) in freshwater systems. It is not currently possible to quantify the potential impacts of nutrient additions to the Athabasca River, although they are not expected to have an adverse effect. The impacts of nutrient enrichment, which in the Athabasca River would be most likely evident as localized increases in algae or other aquatic plants, will be readily detected by the benthic monitoring program (Section 4.1.4). If undesirable levels of enrichment occur, Alberta-Pacific will either reduce phosphorus use or implement phosphorus removal in the effluent treatment system.

Nitrogen and phosphorous concentrations will be monitored in mill effluent and the Athabasca River during mill operations.

4.1.3.10 Metals

In a major review of effluents from Canadian pulp and paper mills by McLeay (1987), metals were not discussed, strongly suggesting that they are not a significant environmental issue in pulp mill effluents. Indeed, there are no significant inputs of metals within a pulping operation, although with time some very small quantities of metals may enter process or cooling water as a result of corrosion. These inputs are not expected to have a measurable environmental effect; however, concentrations of zinc and manganese will be monitored in the Athabasca River and in treated effluent during mill operation.

4.1.3.11 Sulphates

The average sulphate concentration in the mill effluent is expected to be in the order of 7 mg/L. Dilution will reduce the sulphate concentration to well below 1 mg/L within 50 m of the outfall. By comparison, background concentrations of sulphate in the Athabasca range approximately from 15 to 45 mg/L.

Sulphate concentrations will be monitored in the Athabasca River during mill construction and operation, as well as in treated effluent.

4.1.3.12 Odour

A major concern raised by local citizens in Fort McMurray was potential impact on their water supply. The Alberta-Pacific effluent may cause some odours in the immediate vicinity of the outfall but is not expected to cause any detectable off-odours in drinking water for downstream users. Effluent odours will be minimized by the long retention time of the effluent

treatment system and by the rapid dilution that will provided by the diffuser outfall.

4.1.3.13 Phenols

The phenolic compounds of principal concern in bleached kraft mill effluents are the chlorophenols. These have been discussed in Section 4.1.3.5. The water quality monitoring programs for effluent and Athabasca River water quality will include phenolics.

4.1.3.14 Sodium, Chloride

The average concentrations of sodium and chloride in mill effluent are expected to be 20 mg/L and 10 mg/L, respectively. Dilution will reduce these concentrations to 1 mg/L and 0.5 mg/L within 50 m of the effluent diffusers. These levels are low compared to Athabasca River background concentrations, which on a mean monthly basis range from about 5 to 30 mg/L for sodium and 1.3 to 10 mg/L for chloride.

Sodium and chloride concentrations will be monitored in mill effluents and in the Athabasca River.

4.1.3.15 Ammonia

Ammonia concentrations in the effluent are expected to be extremely low and well below potentially toxic levels. The monitoring programs for mill effluent and Athabasca River water quality will include ammonia.

4.3.1.16 Water Temperature

Effluent releases to the Athabasca River are not expected to adversely affect water temperatures. During winter, it is

expected that a zone about 4 km long will remain ice-free downstream of the effluent diffuser; this will aid in reaeration.

4.1.3.17 Toxicity

Treated effluent from the mill will easily meet Alberta Environment requirements for non-toxicity, because the secondary biological effluent treatment system proposed provides a long retention time and is resistant to upsets. Further safeguards against effluent treatment system upsets are provided by the extensive spill control measures incorporated in the mill design and the provisions for controlled flow metering of spilled materials into the treatment system.

Effluent toxicity will be monitored by means of acute lethality bioassays as currently required by Alberta Environment and Alberta-Pacific is willing to consider other toxicity monitoring methods as appropriate. Should effluent toxicity be detected, Alberta-Pacific will stop the flow of effluent until the problem can be identified and corrected.

4.1.3.18 Downstream Mixing

The downstream mixing characteristics of treated effluent in the Athabasca River were determined as part of the dissolved oxygen studies. Full vertical mixing is expected to occur within 50 m, providing a dilution ratio of about 20:1 at the 7Q10 flow. Full transverse mixing occurs by Grand Rapids, approximately 200 km downstream of the mill site. The effluent dilution ratios for various flows at Fort McMurray are shown below.

Mean Monthly Flow						
Jan	Mar	May	July	Sept	Nov	7Q10
92:1	86:1	615:1	907:1	470:1	187:1	57:1

4.1.3.19 Local Watercourses

Adequate protection of the two small, local streams was identified as a major environmental issue by many residents living in the immediate vicinity of the mill.

During mill construction, water quality in local streams will be protected by leaving an undisturbed buffer zone along all watercourses and, if necessary, by implementing additional runoff control and containment measures. Fuel storage areas will be remote from watercourses and will be designed to contain spilled fuels, even in the event of total tank failure.

Water quality in local watercourses is not expected to be affected by mill operations. All surface runoff and snowmelt from the mill site will be collected and routed as appropriate either to the effluent treatment system or to a storm drainage settling basin prior to discharge. Contamination of surface water as a result of spills or normal mill operations is unlikely because of extensive in-plant and out-plant spill controls. Provision has also been made for containment of contaminated surface runoff or snowmelt (Section 3.6.2). Safeguards against groundwater-related water quality changes in local watercourses and water wells are discussed in Section 4.1.6.

A surface water quality monitoring program in local watercourses, incorporating baseline data to be obtained prior to mill construction, will be maintained throughout mill construction and operation to protect downstream users (i.e. livestock) and to provide for remedial action in the event of water quality changes.

4.1.3.20 Acidification

Waterbodies in the area surrounding the mill have relatively low susceptibility to acidification because of their high pH, alkalinity and calcium values. No lake or stream acidification is anticipated as a result of the small incremental increase in sulphur deposition that will be caused by mill atmospheric emissions.

4.1.3.21 Peace-Athabasca Delta

There is currently no reasonable method of predicting the cumulative potential future environmental implications of industrial or any other development within the Peace and Athabasca River systems on the Peace-Athabasca Delta environment. Alberta-Pacific believes that these issues can only be addressed through careful and long-term monitoring of all effluent sources (industrial, agricultural and municipal) as part of a comprehensive monitoring program of the Peace-Athabasca receiving environment.

4.1.4 Impacts on Aquatic Life

The Athabasca River in the vicinity of the mill site and downstream provides habitat for pike, walleye, goldeye, white suckers, longnose suckers and lake whitefish, along with several cyprinid species. A habitat assessment carried out in the Athabasca River near the mill

site and downstream revealed no critical fish habitat. The primary concerns with respect to the effects of the mill on fish are therefore acute (lethal) toxicity, chronic (sublethal) toxicity, and tainting resulting from exposure to the mill effluent.

Mill operation is extremely unlikely to result in acute toxicity in the Athabasca River because of the spill and runoff controls incorporated in the design and because of the efficiency of the effluent treatment system. The effluent will be tested on a regular basis to ensure that it remains non-toxic. Rapid dilution by a diffuser outfall system will be a further safeguard against toxicity.

The potential for sub-lethal toxic effects in the Athabasca River will be minimized by mill process selection, rapid dilution of effluent, the large dilution ratio available in the Athabasca River, and the existence throughout the mixing zone of effluent-free portions of river into which fish can move. A benthic monitoring program will be implemented in the Athabasca River during mill construction and operation to allow for early detection of potential chronic toxicity effects. As well, Athabasca River water quality will be monitored on a regular basis during mill construction and operation.

Tainting is not directly harmful to fish and, as explained in Section 4.1.3.8, is not expected to occur as a result of mill effluent releases.

It is not known whether there will be a fish avoidance zone downstream of the effluent outfall. If such a zone were to exist it would likely be very short due to the rapid mixing and dilution effected by the diffuser outfall structure. There is ample provision for fish passage outside any possible avoidance area, since 1) the outfall structure will extend less than a third of the way across the river, and 2) complete bank-to-bank mixing of the effluent will not occur until Grand Rapids, some 200 km downstream, at which point the effluent will be extremely dilute.

Fishermen in Lac La Biche raised concerns regarding the possible effect of kraft mill effluent on movements of fish into Lac La Biche. There is no evidence that significant migrations of fish occur between the Athabasca River and Lac La Biche via Lac La Biche River, and the project is not expected to affect the Lac la Biche fishery.

Increased recreational fishing pressure on nearby reaches of the Athabasca River may occur as an indirect result of the project. The potential for increased fishing pressure will be greatest during the construction period. No other indirect effects of the project on fisheries are foreseen.

4.1.5 Downstream Water Users

The closest licensed users of Athabasca River water downstream of the mill site are at Fort McMurray. Suncor and Syncrude are the only other licensed downstream water users.

Net water consumption by the proposed mill will be much too small to affect the availability of water to downstream users. Water quality changes are expected to be too small to materially affect downstream users, although colour changes may be detectable during periods of low flow. No evidence is available which would suggest that the health of downstream water users would be at risk from pulp mill effluents.

4.1.6 Hydrogeology

4.1.6.1 Existing Environment

Two hydrostratigraphic units underlie the project area. The basal unit is the bedrock, an aquitard composed primarily of shale. Since it is a poor source of water, few of the existing water wells in the area tap this unit. Overlying the bedrock is a

hydrostratigraphic unit consisting mainly of glacial till, sand and gravel. Most of the water wells in the area tap this surficial aquifer. Groundwater in the surficial aquifer is generally about 2 to 10 m below the ground surface, and in the vicinity of the mill site flows predominantly in the direction of the Athabasca River. Some discharge to local ephemeral watercourses may also occur.

Groundwater in the surficial aquifer is generally very hard, slightly alkaline, and high in dissolved iron. Calcium and magnesium are the dominant cations and bicarbonate is the dominant anion. Total dissolved solids concentrations are generally acceptable in terms of potability.

4.1.6.2 Impacts

Local concerns were very high regarding risks of contamination in neighbouring wells. In some areas, mill site grading will require the lowering of groundwater levels, probably by means of ditches. Water collected in these ditches will be collected in a settling basin before discharge to local water courses. Water quality in the settling basin will be periodically monitored.

The risk of groundwater contamination resulting from the mill operation is considered to be very low because:

- site hardening will minimize infiltration of surface runoff;
- both in-plant and out-plant measures will be provided for spill control;
- surface runoff will be collected and directed to the effluent treatment system or the storm drainage settling pond;
- the effluent treatment lagoons will be lined; and
- groundwater quality will be monitored.

Alberta-Pacific will guarantee maintenance of water supplies for local well owners should any project-related effect on well water quantity or quality occur.

The only existing wells that appear to be within the potential sphere of influence of the mill are those to the north and the immediate west of the millsite.

4.1.7 Summary of Aquatic Monitoring Programs

The aquatic monitoring programs planned by Alberta-Pacific will be coordinated by a full-time biologist, beginning two years prior to start-up. The programs include:

- water quality monitoring in the Athabasca River;
- regular effluent quality monitoring;
- a dioxin baseline study and monitoring of dioxin concentrations in edible Athabasca River fish;
- a benthic monitoring program in the Athabasca River;
- water quantity and quality monitoring in local watercourses; and
- groundwater quality and quantity monitoring.

Athabasca River Water Quality Monitoring

The objectives of the river water quality monitoring program will be to establish local baseline data and to track potential construction and operations impacts.

Water quality will be monitored near the mill site for the following parameters on a monthly basis, beginning prior to construction:

- | | |
|------------------------------|-------------------|
| • temperature | • colour |
| • TSS | • sodium |
| • sulphate | • chloride |
| • ammonia-nitrogen | • nitrate-nitrite |
| • total and ortho-phosphorus | • pH |

During mill operations, monthly water quality monitoring will be carried out in the vicinity of the effluent outfall and further downstream for the above parameters and also for:

- BOD
- phenolics
- zinc
- TOC1 or AOX
- dissolved oxygen
- coliform bacteria
- managanese

In the unlikely event of any emergency conditions that might significantly affect water quality in the Athabasca River, Alberta-Pacific will immediately notify both Alberta Environment and downstream users. The mill will cease discharging effluent to the river in such a case until the problem is rectified.

Effluent Monitoring

The objectives of the effluent monitoring program will be to ensure that effluents are being treated to the design and permit standards and to provide an on-site quality check on the efficiency of the effluent treatment system.

The components of the proposed effluent monitoring program are:

- continuous measurement
 - effluent volume
 - pH
 - conductivity
 - dissolved oxygen
 - temperature
- daily (24 hour composite sample)
 - TSS
 - TDS
 - BOD₅
 - true colour

- monthly (24 hour composite sample)
 - threshold odour number
 - chloride
 - total and ortho-phosphorus
 - total Kjeldahl nitrogen
 - TDS
 - phenolics
 - dimethyl trisulphide
 - chlorinated dioxins
 - sodium
 - sulphate
 - ammonia-nitrogen
 - nitrate-nitrite
 - coliform bacteria
 - resin acids
 - TOC1 or AOX
- quarterly (grab sample)
 - standard acute lethal bioassay test
- semi-annually (24-hour composite sample)
 - metals: total Al, As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Se, Ag, V, Zn

Alberta-Pacific will take immediate remedial action should unacceptable levels of any water quality parameters be detected in the monitoring program. Should the bioassay test show toxicity, studies will be initiated to determine the source of the toxic components and appropriate measures will immediately be taken to eliminate the toxic material from the effluent and to prevent the discharge of toxic effluent into the Athabasca River.

Dioxin Baseline and Monitoring Studies

The purposes of the dioxin monitoring program will be to:

- obtain baseline information on chlorinated dioxin concentrations in edible fish in the vicinity of the mill site, and

- monitor chlorinated dioxin concentrations in Athabasca River fish near the mill site in order to ensure that mill effluent releases do not cause dioxins to accumulate in the aquatic environment.

It is anticipated that details of the dioxin monitoring program will be worked out in cooperation with Alberta Environment and Environment Canada. The program is unlikely to include monitoring of dioxins in river water samples, as concentrations are likely to be below the threshold of detection; however, dioxin measurements will be included in the effluent monitoring program.

Benthic Monitoring

The purpose of the benthic monitoring program will be to provide a means of detecting potential chronic (i.e. long term) effects of effluent releases to the Athabasca River that are too subtle to show up in the water quality monitoring program. Benthic organisms such as aquatic insects are used for this purpose because they are generally equally or more sensitive to low concentrations of contaminants than are fish, and much less mobile. The monitoring program will consist of an annual study and analysis of benthic population structures at a series of sampling locations in the Athabasca River above and below the effluent outfall.

Water Quality and Quantity Monitoring in Local Watercourses

A monitoring program for the intermittent watercourses close to the mill site (locally known as Bear Creek and Deer Creek) will be initiated in order to:

- obtain baseline data on water quantity and quality in Bear and Deer Creeks; and
- ensure that no deterioration in water quality or decrease in water yield occurs during mill construction or operation.

Flow rate and water quality will be measured in the streams on a regular basis throughout the portion of the year when flows occur, commencing prior to construction and continuing into the mill operation phase of the project. The parameters measured will include:

- dissolved oxygen
- pH
- conductivity
- sodium
- chloride
- sulphates
- manganese
- zinc
- iron
- total phosphorus
- ammonia-nitrogen
- total Kjeldahl nitrogen
- nitrate-nitrite
- COD
- TDS
- TSS
- true colour
- oil and grease
- stream discharge

Water quality sampling will also be carried out periodically for the surface runoff collected in the storm drainage settling pond prior to discharge, and additional monitoring will be undertaken as required in the event of a spill incident.

There will be no discharge from the storm drainage settling pond should unacceptable levels of any water quality parameter be detected in the monitoring program. In such a situation, the water will be diverted to the effluent treatment system. Alberta-Pacific will take immediate action to rectify any mill-related water quantity or quality problems in local watercourses and, if necessary, will provide an alternative water supply to local water users.

Groundwater Monitoring

The proposed groundwater monitoring program is designed to detect groundwater quality changes on-site so that remedial action can be taken before off-site groundwater quality is compromised. Groundwater

quality will be monitored by means of a series of on-site and off-site wells, which will be installed prior to construction. The wells will be situated both upgradient and downgradient of the overall mill site and of specific areas such as the effluent treatment lagoons and the solid waste disposal sites. The following parameters will be measured in the monitoring wells on a monthly basis throughout mill construction and operation:

- pH
- chloride
- conductivity
- total and ortho-phosphorus
- manganese
- iron
- water level
- sodium
- sulphate
- nitrate-nitrite
- phenolics
- zinc
- TOC1 or AOX

In the event that groundwater changes are detected on-site, immediate remedial action will be taken to prevent off-site groundwater users from being affected. Alberta-Pacific will provide alternative sources of water for local well-owners should any adverse project-related effect on well water quantity or quality occur.

If dewatering of the surficial aquifer is required during site grading, drainage water quality will be periodically monitored.

4.2 ATMOSPHERIC IMPACTS

4.2.1 Introduction

Of the potential atmospheric effects of the Alberta-Pacific mill, those related to sulphur emissions and deposition are regarded as of the most technical concern and, therefore, received significant emphasis during the assessment of atmospheric impacts. The potential impacts of chlorine and oxides of nitrogen emissions have also been addressed, as

have the topics of odour and fogging. Odour was of particular concern to most area residents and was even raised as an issue in Fort McMurray. In general the public did not distinguish between individual types of atmospheric pollutants, but rather was concerned about collective sources of sulphur odour, and, for local residents, particulates. Details of the atmospheric impact assessment are presented in Appendix 2 of this report.

4.2.2 Existing Meteorological Conditions

Long-term climatological data have been collected by Environment Canada at five stations in the vicinity of the project area: Lac La Biche, Athabasca, Calling Lake, Wandering River and Slave Lake. The Lac La Biche data have been emphasized in the atmospheric impact assessment, as 1) wind data are not available for Athabasca, Calling Lake and Wandering River, and 2) Slave Lake is more than twice as distant from the mill site as Lac La Biche, as well as being less topographically representative of the mill site.

The climate of northeastern Alberta in general is continental, being characterized by long, cold winters and short, cool summers. Mean daily temperature at Lac La Biche ranges from -18.7°C in January to 16.1°C in July and averages 1.0°C year-round. The extreme temperatures of record are 33.9°C and -48.3°C . On average, the frost-free season is under 100 days.

Precipitation follows a summer-high, winter-low pattern and averages 483.5 mm annually, 74% of which falls as rain. Rainfall occurs primarily during the period May through September, with a pronounced peak occurring in July. The greatest 24 hour rainfall on record, 81.5 mm, occurred in June, but intense rainstorms also occur in July and August. Snowfall occurs mainly during the period October through April. December is, on average, the highest snowfall month, but the most intense snowstorms appear to occur in May, September and October.

There are two prevailing wind directions: west to northwest during summer and early fall, and south to southeast during the late fall, winter and early spring. Mean wind speed varies only slightly during the year, although maximum hourly and gust speeds peak noticeably during the fall. The strongest winds are from the west.

Fogs occur on average 17 days per year, the maximum monthly frequency being 3 days, in August. Winter fogs are relatively uncommon, particularly during daytime hours. Recorded occurrences of haze or smoke average one per year.

Dispersion conditions, as measured by the ventilation coefficient (the product of the mixing height and mean wind speed) are most favourable in summer and least favourable in winter.

4.2.3 Existing Air Quality

No on-site background air quality data are currently available but air quality is likely representative of similar agricultural communities throughout Alberta. Local ambient air quality will be monitored for hydrogen sulphide, sulphur dioxide, total hydrocarbons and oxides of nitrogen, beginning prior to construction.

4.2.4 Impacts of Atmospheric Emissions

Maximum ground and treetop level concentrations of gaseous emissions from the mill have been calculated using the Alberta Environment "STACKS" computer dispersion model. This is a simple dispersion model that considers "worst" conditions in determining a maximum concentration, its distance from the source, the wind speed under which it would occur, the contributions of individual emission sources to the maximum concentration, and effective stack heights under the conditions selected. Information input to the model in the dispersion analysis included:

- stack locations,
- stack characteristics and emission data,
- topographic features surrounding the mill site, and
- locations of tree canopies.

4.2.4.1 Hydrogen Sulphide

Dispersion modelling of hydrogen sulphide (H_2S) included the emissions from the recovery stack, lime kiln, smelt tank, and slaker scrubber. The maximum treetop concentration calculated was 0.001 ppm as a one hour average, located 1300 m downwind from the lime kiln at a 2.5 m/sec critical wind speed. This maximum concentration was entirely attributable to smelt tank emissions. H_2S -bearing vent streams were not considered in the dispersion analysis because they will be collected and incinerated, the sulphur being either absorbed in the process circulation or emitted as sulphur dioxide.

The calculated maximum H_2S concentration at tree top level of 0.001 ppm is an order of magnitude below the prescribed maximum one hour ground level concentration of 0.010 ppm.

4.2.4.2 Sulphur Dioxide

Sulphur dioxide (SO_2) dispersion modelling included emissions from the recovery stack, lime kiln and power boiler and indicated that the maximum one-hour tree top concentration of SO_2 under normal operating conditions will be 0.030 ppm, about 2000 m from the sources. This figure includes emissions resulting from the incineration of vent streams. Of the calculated maximum concentration, 0.028 ppm was contributed by the recovery stack and the remainder by the power boiler.

The calculated maximum SO₂ concentration of 0.030 ppm is substantially below the prescribed ambient one hour limit of 0.170 ppm.

4.2.4.3 Chlorine and Chlorine Dioxide

Chlorine and chlorine dioxide emissions originate from the bleach plant and chemical preparation areas. Dispersion modelling indicated maximum one-hour tree top concentrations of 0.004 ppm for chlorine and 0.011 ppm for chlorine dioxide. These concentrations are well below the Ontario one-hour maximum standards of 0.10 ppm for chlorine and 0.03 ppm chlorine dioxide, which are likely to be adopted in Alberta.

4.2.4.4 Oxides of Nitrogen

Oxides of nitrogen (NO_x) emissions dispersion modelling included emissions from the recovery stack, power boiler and lime kiln. The calculated maximum tree top concentration was 0.007 ppm, well over an order of magnitude below the prescribed maximum one-hour ground level concentration of 0.21 ppm.

4.2.4.5 Particulates

Maximum ground level concentrations of particulates downwind from the mill were not calculated. Alberta Environment does not require dispersion modelling for particulates, but does set maximum particulate concentration standards for each stack. These are expected to vary between 100 and 150 mg/m³. Particulate emissions from the mill will be controlled by electrostatic precipitators to meet Alberta Environment requirements.

4.2.4.6

Sulphur Deposition

The Alberta Environment program SULDEP III was used to assess potential annual sulphur deposition rates resulting from operation of the pulp mill. In using this program, it was assumed that sulphur emissions from the plant would be at the maximum levels expected during normal process operations. Stability, wind speed and wind direction (STAR) data from Slave Lake were used in the deposition model as STAR data for Lac La Biche are not available.

The recovery stack will be the major source of sulphur emissions from the mill, exceeding all other sources combined by an order of magnitude. Accordingly, the recovery stack was the only source modelled.

The predicted maximum sulphur deposition rate is 2.1 kg/ha/yr at a location approximately 4 km east of the mill site. The highest values occur in two separate zones corresponding to the prevailing wind directions, one west to west-northwest of the mill site and the other east to southeast. The predicted maximum deposition rates at La La Biche and Athabasca are 0.10 and 0.02 kg/ha/yr, respectively. Approximately 10% of the total sulphur deposition is expected to occur within a 100 km radius of the mill site. Predicted deposition rates close to the mill are shown in Figure 4.2; those further away are summarized in Table 4.

The calculated maximum sulphur deposition rate of 2.1 kg/ha/yr is about 7.5% of the current background rate, which is estimated to be 28 kg/ha/yr. This small increase in sulphation is not expected to affect the acidity of waterbodies or agricultural soils, but might cause a slight incremental acidification in the most sensitive forest soils.

Table 4.1 Predicted maximum total sulphur deposition (kg/ha/yr) resulting from mill emissions by distance and direction

Distance from mill (km)	Direction from mill							
	N	NE	E	SE	S	SW	W	NW
20	0.11	0.03	0.52	0.44	0.39	0.05	0.70	0.42
30	0.07	0.01	0.30	0.26	0.23	0.03	0.41	0.25
40	0.09	0.02	0.24	0.18	0.17	0.02	0.32	0.23
50	0.06	0.01	0.17	0.13	0.13	0.02	0.24	0.17
60	0.05	0.01	0.13	0.10	0.10	0.01	0.18	0.13
80	0.03	0.01	0.09	0.07	0.06	0.01	0.12	0.08
100	0.02	0.01	0.06	0.05	0.05	0.01	0.09	0.06

The results of the SULDEP III modelling were checked using the ADEPT sulphur deposition program, which takes terrain variations into account. As expected in view of the relatively flat terrain in the region (except for the river valley), the results were very similar and in fact the predicted maximum deposition was the same, 2.1 kg/ha/yr.

4.2.4.7 Odour

Odours will be maintained at absolute minimum levels using modern processing technology. A major component of the process design to minimize fugitive emissions will be to combine individual vent streams into two streams, one for low volumes and high concentrations of H₂S (LVHC stream) and one for high volumes and low concentrations (HVLC stream). Both of these combined streams will be incinerated, the former in the lime kiln and the latter in the recovery boiler.

4.2.4.8 Visibility

On a natural basis, the frequency of fog, haze and smoke is low in the vicinity of the mill site, and it is not expected that this will be materially affected by particulate emissions from the mill during normal operations. The mill site is well away from the Athabasca River valley and is surrounded by generally flat terrain, so water vapour emissions during normal operation are expected to dissipate.

4.2.4.9 Health

In addition to odour, a major concern was the potential effects of mill operations on the health of humans and livestock. A review of available information (Appendix 7) indicated that mill atmospheric emissions will be below the concentrations that affect either humans or livestock, and no project related health issues have been identified.

4.2.5 **Monitoring**

Beginning in June 1989, an on-site monitoring program will begin to collect background air-quality and meteorological data. This program will be expanded once operations commence and is described further in Section 3.3.3.

4.3 **TERRESTRIAL IMPACTS**

The main terrestrial impacts of the project will be associated with forestry operations and therefore lie outside the scope of this report. Forestry operation impacts will be addressed in separate reports submitted to the Alberta Forest Service.

Impacts on agriculture and thus the rationale for site selection since non-agricultural land is common in the region, were of particular local concern. Details of the site selection process are presented in Section 2.2.1 and in Appendix 5. Impacts on the Pine Sands National Area were also of concern.

4.3.1 Geology and Soils

4.3.1.1 Existing Environment

The mill site is located within the Lac La Biche Plain, which is characterized by level to gently rolling landscapes with low local relief. North and west of the mill site the Lac La Biche Plain is interrupted by the valley of the Athabasca river, an entrenched valley about 50 m deep and 300 to 500 m wide at river level.

The dominant surficial material south of the mill site is glacial till. Organic, lacustrine (lake bed) and aeolian (windblown) deposits are widespread closer to the river. The mill site itself is partially situated on one of the few glacial outwash (gravel) deposits in the area. Within the river valley, alluvial deposits occur as terraces, and there are also infrequent bedrock exposures of the Lea Park shale. Three main soil groups dominate in the vicinity of the mill site: Organic soils on organic deposits; Brunisols on aeolian and alluvial deposits; and Luvisols on till, outwash and lacustrine deposits. Limited areas of Chernozems and Gleysols also occur on lacustrine materials.

Test holes (Appendix 8) indicate that within the mill site itself, there is a surficial layer of extremely variable materials from 3 to 14 m thick. This layer, which consists of dune sands, outwash sands and gravels, and lacustrine clays, is generally underlain by a layer of very stiff to hard clay from 3 to 26 m thick. The total depth to bedrock varies from 8 to more than 30 m.

4.3.1.2 Impacts

Terrain alteration will result from excavation and grading during site preparation and infrastructure construction. The amount of excavation required at the mill site is estimated to be in the order of 2,000,000 m³. Much of this amount will consist of sand and gravel that can be used for grading and construction purposes in areas other than the main mill block. Any clay materials removed will be stockpiled for use as lagoon liner. Topsoil will be stockpiled separately. The remainder of the excavated materials will be lightly compacted, graded to appropriate contours, and revegetated to prevent erosion.

Off-site terrain alteration will be minor because of the generally subdued topography, except within the river valley. Within the valley, slopes are moderate in the vicinity of proposed facilities and undue terrain disturbance is, therefore, not expected to occur during construction. Geotechnical investigations will be undertaken prior to construction to minimize the possibility that slope failures will occur.

Removal, burial or alteration of soil materials will be an unavoidable consequence of site preparation and infrastructure construction. Wherever feasible, topsoil will be saved and stockpiled for use in site landscaping and reclamation of disturbed soils. Soil stockpiles will be seeded with grasses and legumes to prevent erosion.

Soil erosion by wind or water will be minimized at the mill site during construction and operation by implementing the appropriate erosion control procedures. Riverbank erosion will be prevented at the water intake and effluent discharge facilities by armouring as required.

The sulphur deposition resulting from mill atmospheric emissions will be small compared to current background levels and will not affect most soils in the region, as they are moderately to highly resistant to acidification; however, the increase in sulphation could cause some slight incremental acidification of the most sensitive soils, particularly sandy soils supporting a forest cover of jackpine.

4.3.2 Vegetation

4.3.2.1 Existing Environment

The project area lies within the dry mixedwood subregion of the boreal mixedwood region of Alberta, which is characterized by mixed stands of deciduous and coniferous trees dominated by aspen poplar. The predominant forest cover types in the project area are pure aspen stands and aspen-dominated mixedwood stands containing either white spruce or jackpine. Other significant forest cover types include riverine balsam poplar, white and/or black spruce, pure jackpine, and black spruce/tamarack bogs. Non-forested vegetation types include shrublands, open muskeg (sedge meadows), and cultivated or other cleared land. Agricultural land is by far the most prevalent of the non-forested vegetation types and is the most common of all vegetation types to the south of the mill site.

No rare plant species or unique vegetation communities are known to occur within the project area.

4.3.2.2 Impacts

Site clearing and access corridor construction will result in the permanent removal of some native vegetation cover, although much of the land affected has already been cleared for agriculture.

Since the vegetation communities involved appear to be typical of the area, no particular importance is attached to this requirement.

No impacts on vegetation are anticipated to occur as a result of gaseous emissions, because maximum ground level concentrations will be well below the standards set by Alberta Environment.

Vegetation within the Pine Sands Natural Area will be slightly affected by the project. Some vegetation loss will occur at the western tip of the Natural Area due to clearing along the right-of-way of the proposed western access highway route, and some additional clearing will be required 1) alongside the right-of-way of the existing NOVA gas pipeline during construction of the water intake and cooling water return pipelines, and 2) at the site of the water intake pumphouse.

4.3.3 Wildlife

4.3.3.1 Existing Wildlife Resources

The project area is located within the distributional ranges of as many as 223 wildlife species, including 175 breeding birds, 42 mammals, 5 amphibians and 1 reptile. No wildlife inventory information specific to the project area is available. For the purposes of this study, the importance of wildlife species and habitats in the project area were assessed using the Management Indicator Species (MIS) evaluation scheme. In this scheme, MIS are selected for each of 10 species groups on the basis of rankings from 1 to 4 assigned in each of the following categories:

- political importance (rare, threatened or endangered)
- economic importance based on trapping and guiding
- subsistence hunting value
- recreational hunting value

- non-consumptive recreational importance
- ecological importance
- ecological vulnerability.

The species with the highest total ranking in each species group is selected as the MIS and is assumed to represent the entire species group for the purposes of impact assessment. The importance of each habitat type is then assessed for each MIS.

The Management Indicator Species selected for the project area were:

- dabbling ducks
- great grey owl
- ruffed grouse
- loggerhead shrike
- snowshoe hare
- lynx
- beaver
- moose.

Two species groups (amphibians/reptiles and colonial birds) are too poorly represented in the project area to warrant selection of an MIS.

Wildlife habitat types within the project area coincide closely with the vegetation units defined in Section 4.3.2. The riverine balsam poplar and mixedwood habitat types were ranked as the most important overall, the aspen and shrub types being the next most important. Cultivated land use ranked as the least important habitat type.

A small lake and wetland area a few hundred metres west of the mill site is moderately important as waterfowl habitat, and Ducks

Unlimited is planning to construct a dam on the outlet stream during 1989 in order to raise and stabilize the lake level.

4.3.3.2 Impacts on Wildlife

Clearing for the mill site and associated facilities will affect approximately 3.5 km² of land, about 2/3 of which has already been cleared for agriculture. Construction-related losses in the range of 21 to 43 ha will occur in each of the spruce/tamarack bog, shrubland, mixed wood and aspen habitat types. None of the habitat losses are considered to be significant on either a regional or a local level, and it is expected that none of the Management Indicator Species will be materially affected by the project. The existing faunal assemblage is therefore expected to remain essentially unaltered. Waterfowl on the small lake west of the mill site are not expected to be negatively affected by project-related noise.

Black bears are known to frequent the Pine Sands Natural Area, and increased visitation at the Poacher's Landing Recreational site (Section 5.3.5) occasioned by mill development could increase the opportunities for bear-human conflicts. The possibility of such conflicts can be minimized by installing bear-proof garbage containers at the recreation site and providing a pamphlet outlining safety measures to be taken in "bear country".

4.3.4 Land Use

4.3.4.1 Current Land Uses

Agriculture is the primary land use in the vicinity of the mill site. Outdoor recreation, trapping, hunting and oil and gas development are secondary land uses. There is also a sawmill at Spruce Valley, southeast of the proposed mill site, and a formally

designated natural area, the Pine Sands Natural Area, along the Athabasca River to the north and northwest of the mill site. All land dispositions within the Natural Area require approval from the Minister of Forestry Lands and Wildlife.

Oil and gas development includes a few active and completed potential natural gas wells and a gas pipeline operated by Nova which bisects the project area and mill site.

Recreational uses are centered on the Athabasca River and the Pine Sands Natural Area, particularly a recreation site called Poacher's Landing, which is located near the east end of the natural area and includes a picnic area and a boat launch ramp. In addition to boating opportunities, the Athabasca River offers sport fishing for walleye and pike.

The mill site itself does not lie within a Registered Trapping Area (RTA), but there are two RTA's located nearby. Beaver and coyote are the staple fur species of almost all trappers in the vicinity of the project area. Other important species are red squirrel, fisher, muskrat and mink.

White-tailed deer is the most important species hunted in the project area, both in terms of total hunter days and number of animals harvested. Moose is the second most hunted and harvested species. A significant number of hunter days also go toward mule deer, although comparatively few animals are harvested. Other animals are not normally hunted in the area.

4.3.4.2

Impacts

There will be a direct loss of approximately 2.3 km² of agricultural land for the duration of the project, mainly at the proposed mill site. A further 1.3 km² of agricultural land lies

within the mill site but will not be occupied by facilities; Alberta-Pacific will consider leasing this land to neighbouring farmers. Some non-farm land areas were considered but severe geotechnical constraints made these areas unacceptable. The buffer zone includes 5.5 km² of land cleared for agriculture. The Company may wish to use some of this land for forestry research but intends to lease the remainder for agricultural use. 98% of the agricultural land affected has a capability rating of 4; that is, it has severe limitations to agricultural use. The remainder is Class 3 land with moderately severe limitations to agricultural use.

Some disruption of agricultural operations near the mill site may occur during construction. Where existing fields are split by the rail line, continuing inconvenience in terms of severance may occur. There will be some changes to existing road patterns in the vicinity of the mill, but alternative road access will be provided where necessary and the local transportation network will remain functionally unaltered. Agricultural soils, crop yields and livestock are not expected to be affected by atmospheric emissions from the mill.

Hydrocarbon exploration and development will be largely unaffected by the project, although a short section of the existing Nova pipeline will have to be relocated.

Existing forest products operations may be benefited by the project, as Alberta-Pacific will purchase coniferous chips from local operators.

Outdoor recreation opportunities should not be materially affected by the mill; however, the perceived quality of recreational experience may decrease in the vicinity of the mill. The demand for recreation opportunities in the area will increase, and it can

be expected that the Poacher's Landing Recreational Area will receive higher use. Construction workers will be discouraged from using the recreational area in order to avoid conflicts with local residents.

Minor habitat losses will occur within two trapping areas to the north and northeast of the mill site. These losses are not expected to affect trapping success. Impacts on trapping within the FMA lie outside the scope of this report.

Construction of the mill will not cause significant losses of important big game, upland game or waterfowl habitat. It is expected that local hunting will be unaffected by the project.

Within the Pine Sands Natural Area, the impacts of mill construction and operation will include ground disturbance and vegetation clearing to allow for construction of:

- the western access highway;
- the water intake and pumphouse; and
- the water supply and warm water return pipelines and associated access road.

Habitat losses within the Natural Area will be too small to materially affect wildlife. Vegetation will not be affected by mill atmospheric emissions. Terrain and vegetation impacts associated with the pipeline and water intake will be mitigated by minimizing the width of clearing and by prompt revegetation of disturbed areas with appropriate species to prevent erosion. The impacts of highway construction will be addressed by Alberta Transportation.

4.3.5 Historical Resources

4.3.5.1 Existing Historical Resources

A historical resources impact assessment comprising a surface reconnaissance and subsurface testing was carried out for the Alberta-Pacific project in the areas that will be occupied by the following facilities:

- the pulp mill and effluent treatment system;
- the raw water supply pipeline;
- the treated effluent pipeline;
- the water intake and pumphouse facilities;
- the foam control pond and outfall/diffuser facilities;
- access roads to the water intake and effluent outfall areas;
- pulp mill access road; and,
- rail spur right-of-way from Boyle to the pulp mill site.

There are no known historical resources in these area and no historical resources were encountered during the field investigations.

4.3.5.2 Impacts

No historical resource impacts are anticipated in the areas examined during the field investigations. Should any revision to the planned location of mill facilities and infrastructure occur, the potential for the alterations to affect historical resources will be evaluated.

Concern has been expressed by Alberta Culture and the Lac La Biche Mission Historical Preservation Society as to whether pulp mill atmospheric sulphur emissions will adversely affect the Lac La Biche Mission site at Lac La Biche. The increase in sulphur deposition at Lac La Biche, as predicted on the basis of both the

SULDEP III and ADEPT computer models, is only 0.3% of current levels, an increment that is too small to measurably affect the Mission site in any way.

4.4 REFERENCES

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5.0 SOCIO-ECONOMIC IMPACTS

5.1 INTRODUCTION

The Alberta-Pacific pulp mill site is located 36 km north of the Village of Boyle in the County of Athabasca, approximately 160 km northeast of Edmonton. The communities of Athabasca and Plamondon are both about 47 km by road from the site and Lac La Biche is about 20 km further. All four communities are within daily commuting distance of the mill site (i.e. under 45 minutes - one way).

Approximately 27,000 person-months of labour will be required to construct the mill over 3 years. The on-site labour force will likely peak at 2,600 people, with on-site accommodation for up to 1,900 being provided in a construction camp. Infrastructure required to service the mill during operations includes water from the Athabasca River, a rail spur line to provide for chemical deliveries to the mill and for shipment of outbound pulp, new and upgraded access roads, a 138 kV power line, and a natural gas supply line.

5.2 PROJECT REGION

5.2.1 Background

The pulp mill primary socio-economic impact region is shown in Figure 5.1. This region includes the County of Athabasca and portions of Improvement Districts 17 and 18. Located within this broadly defined region are the urban communities of Athabasca, Boyle, Lac La Biche and Plamondon. Other communities in the region include the Indian Reserves of Calling Lake, Beaver Lake, and Heart Lake and the Metis Settlement of Beaver River (Kikino), which is located just east of Boyle.

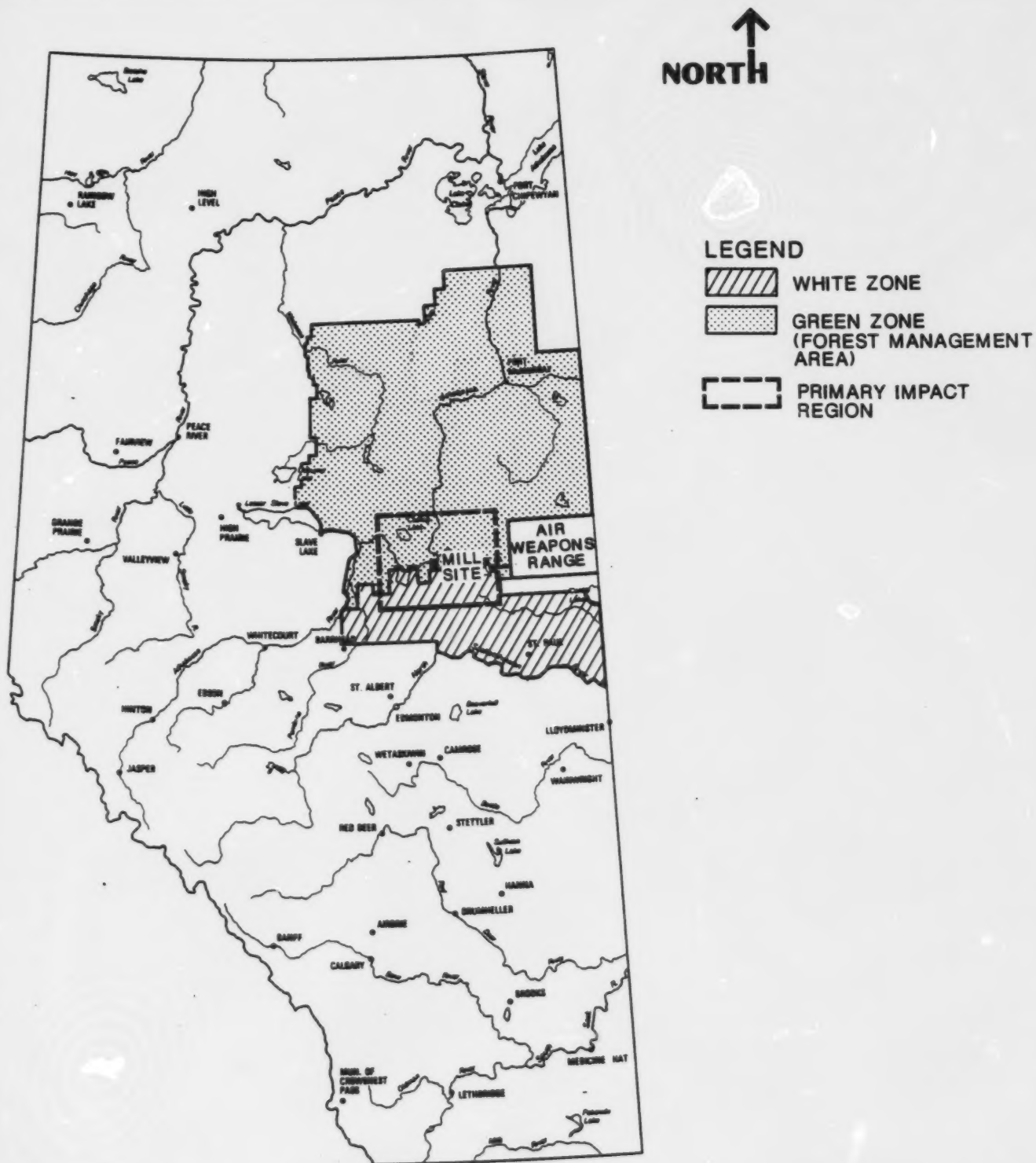


Figure 5.1

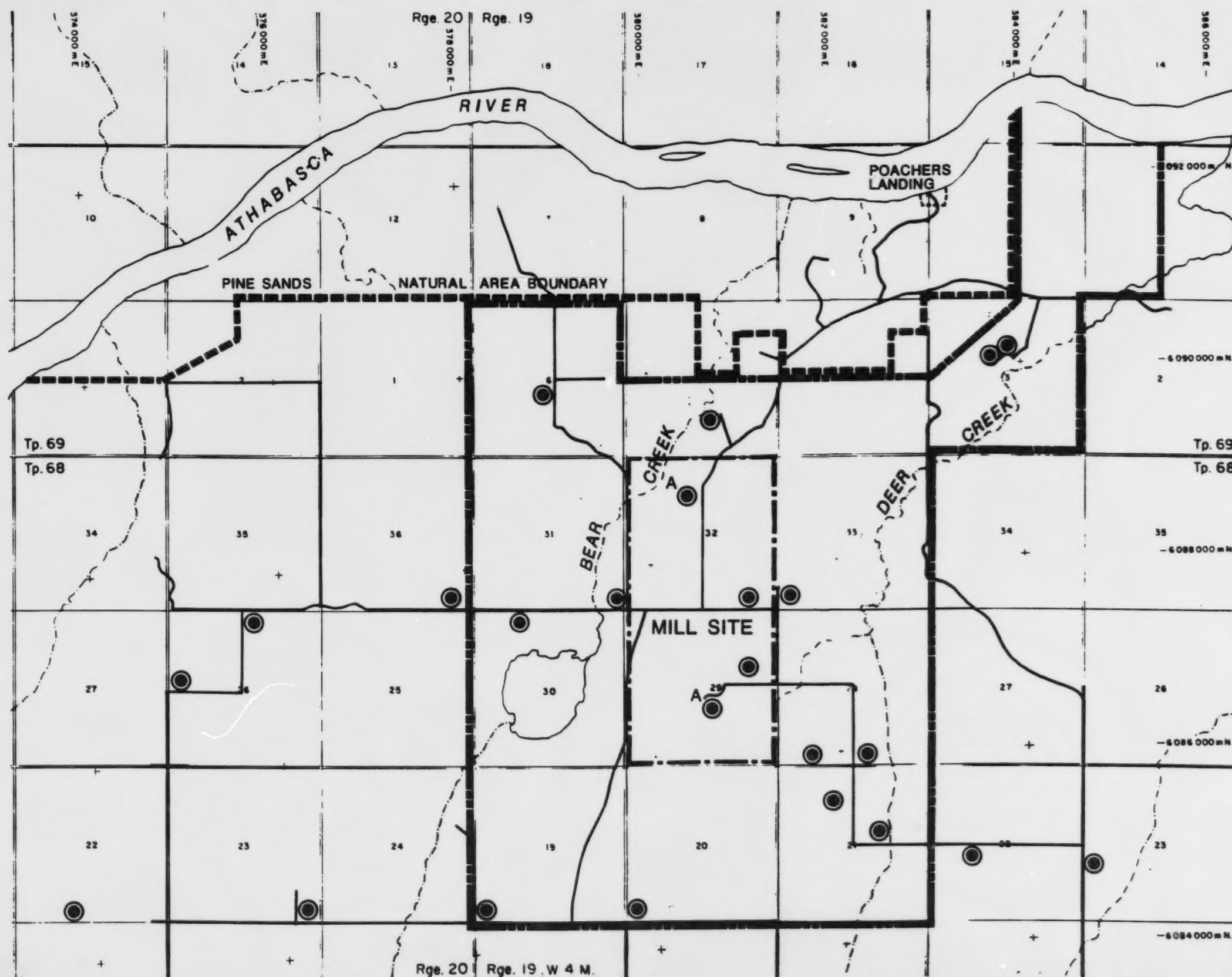
PROJECT REGION

The primary impact region contains substantial water resources. The Athabasca River is the largest stream in the region; other local streams include Pine Creek, Wandering River and Lac La Biche River. The largest lake in the region is Lac La Biche, upon which is located the town of the same name. Calling Lake, north of the Town of Athabasca, is the second largest lake in the region. Numerous lakes abound from Boyle to the eastern Boundary of the region and form the western edge of the Lakeland District, which extends from Boyle to the Saskatchewan border and, as well, several small lakes are located in the forested areas west of the Town of Athabasca.

Transportation infrastructure in the region includes four major Provincial Highways: #2, #63, #55 and #36. Another major road is S.R. 813, which links the Town of Athabasca to Calling Lake and is currently being extended northwest to Wabasca/Desmarais. Rail service is provided by the CNR to the region through two rail lines; one of these serves Athabasca and is used primarily to transport grain from the railhead while the other runs from Edmonton to Fort McMurray and is currently used to transport sulphur trains from the oil sands plants and grain and lumber from Lac La Biche and Boyle. This line is undergoing continuous upgrading and will continue to be the major industrial rail line serving the region now and in the future.

5.2.2 Population and Labour Force

The population of the primary impact region (as of 1986) is estimated to be 15,000, of whom approximately 2,500 live in Lac La Biche, 2,000 in Athabasca, 700 in Boyle, and 200 in Plamondon. Both major towns are growing, whereas the two villages and the County of Athabasca have remained relatively stable. The estimated proportion of the population employed in the labour force (48%) is below the provincial average of 54%, and reflects the resource nature of the economy. However, Lac La Biche and the Town of Athabasca are close to the



NORTH ↑

LEGEND

- EXISTING ROADS
- LOCAL DEVELOPMENT AREA
- EXISTING FARMSTEADS
- A ● ABANDONED FARMSTEADS

SCALE



Figure 5.2

MILL SITE
LOCAL DEVELOPMENT AREA



provincial average, reflecting the service sector employment associated with government, quasi-government, and education institutions located in these communities.

An age-sex breakdown of the primary impact region population indicates a socio-economic environment characterized by an aging population, a deficiency of people of child-bearing age, and larger than average family sizes. This reflects a situation where, without new regional employment opportunities, young adults migrate out of the region in search of work elsewhere.

5.2.3 Economic Base

The economic base of the primary impact region consists of agriculture, gas and oil, forestry, fishing, post-secondary education, public administration and tourism.

5.2.4 Housing

Housing in the primary impact region is available in the urban communities of Athabasca, Lac La Biche and Boyle. Country residential development on non-farm properties is extensive around Lac La Biche (the lake) and Skeleton Lake, east of Boyle.

5.2.5 Education

5.2.5.1 Primary/Secondary

The primary and secondary school systems are operated by the County of Athabasca and the Lac La Biche School Division. Present (1987/88) enrolments, school capacities and utilization data indicate that the urban schools are generally well utilized and that the rural ones are severely underutilized. Over the entire

region, school enrolment in 1987/88 totaled 3,940 students and overall utilization was 67.9%.

5.2.5.2 Post Secondary

There are two post-secondary institutions in the region: Athabasca University in Athabasca and the Adult Vocational Centre (AVC) in Lac La Biche.

Athabasca University offers undergraduate degree programs in administration, arts, and general studies, as well as university certificate programs in administration and public administration.

The Alberta Vocational Centre offers courses in business careers, human services, trades, technical programs, and academic upgrading. Courses already offered that are of relevance to the pulp mill and forestry operations include forestry crew worker, power engineering, carpentry, welding, motor mechanics, accounting, administration, typing and word processing.

5.2.6 Hospitals

There are three hospitals in the region, one in each of Athabasca, Lac La Biche and Boyle, between them totaling 144 beds. Utilization is high in Athabasca and Lac La Biche but low in Boyle.

5.2.7 Recreation and Tourism

There are numerous recreational opportunities in the Athabasca/Lac La Biche region in both the urban and rural areas. Recreational infrastructure in the urban areas includes an indoor arena and a curling rink in all four communities, a golf course in Athabasca, Lac La Biche and Boyle, and a swimming pool in Athabasca. There are

numerous outdoor recreation opportunities, including hunting, fishing and boating on the numerous lakes and rivers in the area, as well as snowmobiling and cross country skiing. Facility-oriented outdoor recreation opportunities are available at Pine Sands Natural Area and at Calling Lake, Sir Winston Churchill and Long Lake provincial parks.

Tourism in the Region is currently restricted mainly to Alberta residents; however, there is considerable potential for increased attraction of non-local visitors. The proposed Lac La Biche Mission and Tawatinaw Trail Interpretive Center developments are current local initiatives that will raise the profile of the area as a tourism destination point.

5.2.8 Urban Infrastructure

The four urban communities within the primary impact region are all well serviced with water supply and sewage treatment systems. The capacity of these systems is approximately double the 1986 population in each case.

5.3 ECONOMIC AND COMMUNITY EFFECTS

The capital investment of some \$1.3 billion to construct the pulp mill and related infrastructure over a 3 year period will bring substantial socio-economic benefits to the region. Over 20 years of operation, it is estimated that an additional \$3.2 billion will be spent. Capital investment of a further \$300 million to build a paper mill could also take place in response to favourable market conditions and industrial synergy.

5.3.1 Employment and Income

5.3.1.1 Construction

Estimated direct employment in the primary impact region during construction of the pulp mill will be 33,600 man-months over three years (1989-1991), an increase in employment of about 13%. The gross payroll will be some \$152 million. Approximately 80% of project-related employment will be focussed upon the pulp mill itself, the remainder being associated with the construction of a rail spur and roads outside the mill fence and housing in the communities. In addition, some 5,040 man-months of indirect employment are expected to result from construction.

The construction-related employment and payroll figures for all Alberta (including the region), obtained using appropriate economic multipliers, are 80,400 man-months and \$250 million; for Canada as a whole they are 114,000 man-months and \$320 million.

In order to ensure that the maximum economic benefits of construction accrue to the local community, Alberta-Pacific will provide for union/non-union hiring of labour by major contractors at the mill site as well as in Edmonton. In addition, all Alberta-Pacific personnel will be hired at the mill site.

5.3.1.2 Operations

Direct employment resulting from pulp mill operation is estimated to be 1100 people: approximately 440 to operate the pulp mill and about 660 more (full-time equivalent) to supply wood to the mill. Over 20 years of operation, this will generate an estimated gross payroll of some \$990 million. Total direct and indirect employment in the Athabasca/Lac La Biche region is estimated to be

1050 jobs; in the overall project region it is estimated to be 1,925 jobs with a gross payroll of \$1.3 billion. Corresponding figures are 2,750 jobs and \$1.6 billion for Alberta, and 3,850 jobs and \$2.0 billion for Canada.

Alberta-Pacific will hire and train, over a two year period, 100-150 people, including graduating high school students, for eventual employment at the mill.

5.3.2 Business Opportunities

A number of business opportunities will be created in the region as a result of the project. Some of these are listed below.

Construction

- clearing and grubbing
- fencing
- trucking
- camp set-up
- catering
- sand and gravel supply
- training
- housing
- fuel supply
- hotel/motel
- food and beverage

Operations

- specialty maintenance shops
- auto and truck dealers
- warehousing/distribution

- trucking
- forestry consulting
- security
- logging
- wood chip supply
- logging road construction

Business seminars will be conducted by Alberta-Pacific throughout the project in the region to allow local businesses to become familiar with the opportunities and to submit bids on contracts.

5.3.3 Population Growth

Population increase during construction in communities will be minimized due to the location of a construction camp at the site. Population increase in the primary impact region outside the camp due to indirect employment could amount to some 600 people or 4%.

The expected creation of 1,050 jobs within the Athabasca/Lac La Biche region during the mill operating period will result in a permanent increase in the population of the immediate area within commuting distance of the mill. The resulting population growth in the region expected to occur by 1992 as a result of direct, indirect, and induced employment during operations is 2,000 people, an increase of 13% in the existing population of 15,000. The estimated population increases by area are: Athabasca and Boyle, 925 (35%); Lac La Biche and Plamondon, 615 (22%); rural, 400 (4%).

In the northern portion of the project area, an additional 875 new jobs will be created and, under the same assumptions, the population can be expected to increase by about 1,600 people by 1992.

The implications of the anticipated population increase of 2,000 in the primary impact region can be summarized as follows:

- New housing totaling an estimated 665 units will be required to house the population influx.
- The regional supply of developed and undeveloped residential lots is sufficient to accommodate new population growth resulting from the mill.
- Sufficient excess capacity exists in water and sewage systems in the towns, villages and hamlets to accommodate all of the anticipated growth.
- New elementary schools may be required in both Athabasca and Lac La Biche to accommodate future growth.
- Existing hospitals have enough excess capacity to accommodate the expected increase in demand for medical services anticipated as a result of the project.
- Some additional recreation facilities will be required in the region; however, better utilization of existing facilities should also result, making them more economically viable.

5.3.4 Housing Requirements

An estimated 665 new housing units will be needed in the region to accommodate the population influx. This figure is based upon 510 families requiring single family units and 155 singles requiring multiple units (townhousing, apartments, etc.). It is assumed that 75% of the incoming population will require new housing while the remainder will rent or purchase existing, vacant accommodation. It appears that

the present supplies of residential lots in the urban and rural communities in the area are more than sufficient to absorb any anticipated population increase resulting from the project. Information about projected housing needs will be provided to area municipalities through presentations, open houses and meetings with Alberta Municipal Affairs.

5.3.5 Education

An estimated 575 students will be added to the elementary/secondary school systems in the region. Of these, between 60% and 75% are expected to reside within the County of Athabasca School System, and 25% to 40% within the Lac La Biche School System. Although on a regional basis the additional students represent only about 30% of the available capacity, some pressure may be exerted upon schools in Lac La Biche, Plamondon and Athabasca. An additional elementary school may be required for both Lac La Biche and Athabasca, depending upon the distribution of the population increase.

Training programs will be initiated by Alberta-Pacific, and discussions with both the Adult Vocational Centre in Lac La Biche and Athabasca University are now underway.

5.3.6 Medical/Social Services

The demands placed by an additional 2,000 people upon the medical and social services in the region are not expected to be significant. A demand for 10 additional hospital beds can be expected, assuming a standard of 5 beds per 1000 people. The 144 hospital beds in the region as of 1986 are sufficient to accommodate a regional population of 28,400 people, and the expected population increase will help to better utilize existing facilities; however, the hospital at Athabasca may need to be expanded to allow for normal growth since the

utilization level is currently 91%. Alberta-Pacific will discuss projected additional medical service requirements with local and regional medical authorities.

5.3.7 Recreation and Tourism

There will be a need for increased recreation services in communities that experience growth as a result of the project; however, the wide variety of outdoor recreational opportunities in the region may lessen the demand for community recreation by comparison with what might be the case in less well endowed areas. Along with the increase in recreation services required, the provincial Community Recreation and Cultural Grant program will contribute \$20,000 of additional resources to the municipal and community recreation budgets in 1991. A portion of the additional tax dollars gained by the County of Athabasca from the pulp mill can be used to offset the costs of operating recreation facilities in Athabasca and Boyle through recreation agreements. In the cases of Lac La Biche and Plamondon, some arrangement may be reached with the Province for additional assistance.

Existing and proposed tourist attractions are not expected to be adversely affected by construction or operation of the pulp mill.

5.3.8 Municipal Taxes

Annual municipal taxes payable by Alberta-Pacific to the County of Athabasca could range from \$1.6 million to \$4.0 million. The exact amount is difficult to predict at this time due to uncertainties about the manner in which the various elements of the mill will be assessed and the overall revenue requirements of the County. Taxation amounts are usually decided as part of the negotiation process between the company, County and Province. Regardless of the amount determined, the impact on County revenues will be substantial. The County will likely

also need to carry out discussions with municipalities within its boundaries on cost sharing programs, and the Province and I.D. #17 will likely conduct similar discussions with Plamondon and Lac La Biche.

5.3.9 Transportation/Utilities

Regional transportation will be improved with the construction of a new highway bridge across the Athabasca River. This bridge and associated highway system improvements will provide a direct road link between the Wabasca/Calling Lake area and the Lac La Biche area (Figure 2.1).

A 36 km rail spur will be built from Boyle to the mill site. The resulting additional rail traffic on the CNR line at Boyle will increase the economic viability of the existing rail line between Edmonton and Fort McMurray.

The mill will require a 138 kV tie line to be constructed from the existing transmission line connecting Boyle and Lac La Biche.

Natural gas is available on site from a pipeline owned and operated by NOVA.

Wherever possible, the rail and power lines will be combined into a single transportation and utility corridor in order to minimize the impact of severance. The practicality of combining the two will be determined following preliminary rail route selection engineering studies.

Truck traffic into the mill will largely consist of trucks supplying either logs or chips. The majority of truck traffic will originate in the Calling Lake/Wabasca area and will use the new proposed highway connecting to the mill site via a new bridge across the Athabasca River. Another major truck traffic flow will come from the northeast

via Highway 63, the remainder of the traffic being shared between Highway 55 east and west. Gross vehicle weights of 60 tonnes will be used in the transport of logs to the site. A network of off-highway logging roads will eventually be built to minimize the amount of logging traffic on provincial highways.

5.4 LOCAL MILL SITE COMMUNITY

The local agricultural community in the mill site area is known as Spruce Valley/Sandy Ridge and consists of 60 to 65 families with about 200 people. The other local communities are Willow Flats, Prosperity, Green Pine and Blue Jay.

The closest urban community to the agricultural communities in the immediate vicinity of the mill site is Grassland, located 20 km to the southeast. Grassland is a community of about 70 to 75 people with a school, outdoor recreation facilities, and limited commercial development. The community has a water system and a sewage system; 68 parcels of land are presently serviced. In addition, a 45 ha residential subdivision has been planned, the first stage of which will consist of 60 lots, and a 22 unit motel expected to open in 1989 is currently under construction. Fifty people are presently employed in Grassland.

Spruce Valley Mills Ltd., which operates a sawmill in Spruce Valley, is the largest single employer in the local agricultural community. The mill provides 30 full time and 15 part time jobs.

Prosvita Hall, the community hall for Spruce Valley/Sandy Ridge, Prosperity, Willow Flats, Green Pine and Blue Jay is located at Prosperity. Local churches and cemeteries are located throughout the local farming community.

The local road pattern is irregular and reflects the pattern of human settlement in relation to the better agricultural soils. There are two main country roads into the mill site area: the Amber Valley/Prosperity Road and the Spruce Valley Road.

A major natural feature of the local mill site community is the Pine Sands Natural Area, located between the mill site and the Athabasca River. No agricultural activity takes place within the Natural Area, which covers some 1350 ha (5.2 square miles). The Poacher's Landing Recreation Club has developed a recreational lease comprising 15 ha (37 acres) adjacent to the Athabasca River near the east end of the Natural Area. The recreational area includes a boat launch, playground and picnic/camping area, and is connected to a system of recreational trails that extend throughout the eastern portion of the Natural Area.

5.5 LOCAL COMMUNITY IMPACTS

Perhaps the most commonly voiced local issue was concern about the impacts of the pulp mill on the social and economic structure of the immediate community.

5.5.1 People Displaced

Fourteen people, or 7% of the existing local community, will be displaced from 3 farmsteads within the mill site area (Figure 5.2). There are 5 more farmsteads within the 800 m buffer zone around the millsite, representing another 15 people. People presently living within the buffer area may or may not remain living there as the project proceeds, depending upon their preferences and Alberta-Pacific's land purchase policy.

5.5.2 Construction Impacts

The local community will be temporarily affected by the construction of the pulp mill and its infrastructure, which includes:

- a water intake, water pipeline and access road;
- an effluent pipeline, foam control pond and diffuser discharge system;
- natural gas pipeline relocation;
- electrical power tie lines for construction and operations;
- mill site access roads; and
- a rail spur line to the mill site.

Approximately 35 people will experience some disruption as a direct result of construction in the immediate vicinity of the mill site. The area affected covers 34 km² and is referred to here as the local development area (Figure 5.2). Alberta-Pacific will consider purchasing land within the buffer zone around the mill site. Upon purchase of this land it may be leased back to farmers for agricultural use or it may be used for reforestation research plots. The proposed intake pipeline, effluent pipeline, and road routes will be reviewed with local landowners to minimize disruption to farm operations.

There will be a temporary intrusion of up to 1900 people resident in a trailer construction camp at the mill site. This impact will be shortlived and will last approximately a year and a half through 1990 and into 1991. In addition, a small number of trailers will be required on site in the fall of 1989 during site preparation and in the summer of 1991 just prior to mill start-up. The advantages and disadvantages of an on-site construction camp are summarized below.

Advantages

- avoids undue strain on existing regional accommodation;

- significantly reduces the impacts of commuting traffic to and from the mill site;
- provides an opportunity for local companies providing catering and laundry services to bid on contracts; and
- provides some supervision and control of the construction labour force.

Disadvantages

- temporary intrusion of 1400 to 1900 people into a community of 300 people;
- after-hours social impacts of construction workers upon local residents and facilities; and
- possible introduction of alcohol and drugs into the community.

Some increase in the use of local community resources is expected as a result of the influx of construction workers. To avoid unnecessary tension between the local community and construction crews, Alberta-Pacific and their prime contractors will institute strict rules concerning off-site behaviour of construction workers. Reported violations will be investigated and could result in the dismissal of the workers involved. Other concerns of the local community will be addressed through Alberta-Pacific's involvement and discussions with the area residents' committee.

Until the new highway is constructed by Alberta Transportation south from the site to Highway 55, the Spruce Valley Road will be used to transport construction materials to the site. Construction workers hired from the region will commute daily to the site via the existing Amber Valley and Spruce Valley roads. In order to minimize the effects of construction traffic on the Spruce Valley Road, construction workers will be encouraged to use car pools and the County will be asked to maintain and oil the road on a regular basis.

Road closures in the mill site will cut off some traditional communication links within the northern edge of the Spruce Valley/Sandy Ridge farming community; however, alternative road access will be provided and the local transportation network will not be functionally altered. A road closure plan will be developed by Alberta-Pacific, in conjunction with the County and pulp mill area residents' committee, in order to minimize the impacts of road closures and industrial traffic.

Beyond the local development area, construction impact will be focussed upon a transportation/utility corridor about 110 m wide routed south from the mill site to Highway 55 along the quarter section line. The development of this corridor will affect 11 farmsteads, and will be subject to further environmental assessment by the organizations responsible for development.

5.5.3 Operations Impacts

The main transportation-related impacts during operations will result from wood hauling. Logs and chips will be trucked to the mill on a proposed new highway connecting east from the mill site to Highway 63 and northwest to Highway 813 and Calling Lake. Most of the wood haul will be during winter, when daily truck volumes are anticipated to be 230 from Calling Lake and 175 from Highway 63. These are high numbers of truck movements but the impacts will be minimized by the fact that the proposed highways pass mainly through undeveloped crown lands. Summer wood haul volumes are expected to be approximately 30% of winter volumes. Smaller transportation impacts will occur south of the mill site as a result of truck deliveries of supplies, mill employee commuting, and rail traffic. Daily rail movements are expected to average 5 to 6 inbound cars carrying chemicals and 30 outbound cars carrying pulp, 345 days per year.

A limited amount of local concern was expressed regarding the aesthetic impact of the mill. The Alberta-Pacific pulp mill is set sufficiently far back from the Athabasca River so that it will not be visible from the river valley. The relatively flat terrain to the east, south and west of the mill site will, however, make the mill visible from these directions. In order to reduce local aesthetic impacts, Alberta-Pacific will:

- implement a landscape plan around the administration, parking lot, and site access areas;
- carry out a tree planting program; and
- revegetate unused areas disturbed during construction.

Dust will be controlled on-site as required by the application of calcium chloride.

The building of the pulp mill and associated infrastructure will undoubtedly result in numerous changes to the existing local agricultural community. To aid the community in adjusting to the new environment, Alberta-Pacific is prepared to work with mill site community residents. Alberta-Pacific proposes to meet regularly with the mill site residents' committee to discuss any matters of mutual concern. In this fashion, any unforeseen impacts of the mill and associated operations on the local community can be dealt with in a timely and appropriate manner.

5.6 NATIVE AFFAIRS SOCIO-ECONOMIC POLICIES AND PROGRAMS

The Alberta-Pacific Forest Industries Inc. bleached kraft pulp mill will provide a focus for a wide range of Native interests concerning training, employment and business opportunities, and potential changes in community lifestyles, services and infrastructure. There will be both benefits and costs for Native people in the area. In order for Native people to be able to obtain the greatest possible net benefits from the pulp mill, Alberta-Pacific, its contractors, the government of Alberta and Native community leaders must all contribute to the development of an impact management strategy or policy for the project. Alberta-Pacific, as the project proponent, has a central role in this process and is proposing impact management policies and programs in three main areas:

- information, consulting and monitoring
- Native benefits
- mitigation and compensation.

In developing these policies and programs, Alberta-Pacific has considered the following impact management perspectives, many of which were raised in discussions with northern native leaders:

- To react constructively to the Project, Native people require timely and relevant information about the pulp mill.
- Since the number and type of economic opportunities in the region are limited, Native people and businesses may want to participate in project opportunities to the maximum extent practicable, particularly during the operation phase.
- Alberta-Pacific's abilities to encourage Native employment during construction are heavily influenced by other parties, particularly government and contractors.

- The maximum practicable use of northern contractors is one of the best ways of ensuring Native employment during the construction phase.
- During construction, Project employees and transient immigrants seeking project-related jobs are potential sources of social problems in some Native communities.
- Project operations could disrupt trapping harvest activities in some areas, causing loss of income.

Alberta-Pacific anticipates considerable discussion on program elements as they are transformed into a Socio-Economic Action Plan. Native community consultations will provide an important forum for such discussions.

5.6.1 Information, Consulting and Monitoring

Alberta-Pacific will endeavour to make relevant project information available and accessible to all interested Native parties on a timely basis. Alberta-Pacific will consult and work closely with Native community leaders, the Alberta government, and other appropriate parties during the planning, construction and operation phases of the project to ensure that potential benefits are fully realized and that potentially adverse effects are minimized for Native people of the region. Alberta-Pacific will monitor the application of the Socio-Economic Native Affairs Policies and Programs in order to assess their effectiveness and modify their delivery as required.

These policies will be implemented through the following programs:

- information and liaison
- consultation
- project organization
- monitoring of socio-economic effects.

Information and Liaison

In order to optimize the dissemination of information about training, employment and business opportunities, Alberta-Pacific will:

- ensure timely presentation of information about training and employment opportunities at the Native community level;
- require contractors to make information about employment requirements promptly available for Native community dissemination;
- establish a toll-free telephone service to enable Native community residents to make enquiries about training, employment and business opportunities;
- prepare and keep updated a listing of project requirements and business opportunities that could be of special interest to Native businesses;
- visit Native communities to meet with Native businessmen in order to assess their business capabilities and discuss project requirements;
- prepare and continually update a list of Native businesses that are interested in, and potentially capable of participating in project supply opportunities; and
- locate a project office at the site, as soon as possible, to improve accessibility to business opportunities for Native business.

Consultation

Alberta-Pacific feels that a regional Native advisory group(s) would assist the company in ensuring that regional and local concerns are taken into account during planning. The terms of reference, composition and reporting procedures of such an advisory group, or the means by which existing regional groups might be used, will be discussed with appropriate Native community leaders.

Alberta-Pacific will consult with appropriate regional Native groups on such topics as:

- development of training programs
- development of a manpower delivery system
- environmental issues
- subsistence living issues and forest management
- Native business opportunities.

Project Organization

Alberta-Pacific will:

- employ or contract a northern Alberta resident as a coordinator to ensure that information on the Project is reaching key government and Native people; and
- ensure that all staff and contractors are knowledgeable of the special interests and concerns of Native people living within the region.

Monitoring of Socio-Economic Effects

Alberta-Pacific will establish a monitoring system that will keep management informed of:

- the effectiveness of the Native affairs socio-economic policies and programs,
- the implications of unanticipated developments,
- suggestions for corrective action made by others, and
- unsettled land claims in the region.

5.6.2 Native Benefits

Alberta-Pacific is committed to enabling Native people and Native businesses in the region to participate in training, employment and

business opportunities generated during the planning, construction and operation phases of the project.

The policies will be established through programs in the following areas:

Native business

Native training

Native employment.

Native Business

Several of the information and liaison activities outlined in Section 5.6.1 are intended to increase opportunities for Native businesses, namely:

- preparation of a project industrial and service list,
- familiarization visits,
- preparation of a list of Native businesses,
- periodic summaries of Native opportunities, and
- establishment of toll-free long distance telephone service.

In addition, Alberta-Pacific proposes to:

- help Native businesses to prepare bids by providing information about relevant requirements and advice on finding consultants;
- encourage the formation of joint ventures that will facilitate the participation of Native businesses;
- where appropriate, break down project requirements into packages that Native businesses can supply; and
- assist Native contractors by prompt payment of invoices, by provision of on-going technical, supervisory and administrative assistance, and where appropriate by assisting in financing arrangements.

Native Training

Alberta-Pacific will work with the Alberta government to develop and implement a Native training plan. This plan will outline the roles of the government and the company in providing training opportunities that can lead to permanent employment and ongoing career development, and will include the areas of pre-employment, on-site and on-the-job training, orientation and counselling.

Native Employment

An effective construction manpower delivery system for Native residents will require input from Alberta-Pacific, contractors, government manpower agencies and Native groups. As outlined in Section 5.6.1, Alberta-Pacific proposes to facilitate Native employment by means of:

- timely presentation of information,
- establishment of a toll-free telephone service, and
- rapid advertising of job vacancies.

Other Alberta-Pacific initiatives toward Native employment include:

- use of Native contractors as a means of Native employment;
- development of a system of recruiting Native residents, including recruiting trips to Native communities; and
- cooperation with Canada Manpower Centres and Alberta Native Outreach in facilitating candidate recruitment.

5.6.3 Mitigation and Compensation

Wherever possible, Alberta-Pacific intends to reduce or eliminate potentially adverse socio-economic effects of the project on Natives. This policy will be implemented through the following programs:

- location and scheduling of activities and facilities
- control of project personnel

- Native community services and infrastructure
- Native trapper's compensation.

Location and Scheduling of Activities and Facilities

Alberta-Pacific will endeavour to locate facilities and schedule construction so as to avoid interfering with Native activities or disturbing Native cultural areas.

Control of Project Personnel

Disturbance of Native communities or activities by project personnel will be minimized by:

- controlling personnel contact with Native communities
- prohibiting construction personnel from hunting, trapping or having firearms at Alberta-Pacific facilities
- ensuring that all project personnel are made aware of government regulations pertaining to hunting, fishing and trapping throughout the region.

Native Community Services and Infrastructure

Alberta-Pacific will:

- endeavour to ensure that Native communities' requirements for transportation, communications, resupply, housing and government services are not adversely affected by the project

Native Trapper's Compensation

In the context of current practice in Alberta, Alberta-Pacific is prepared to work with government and Native communities to ensure that

appropriate types and methods of compensation are developed prior to the beginning of construction. A detailed Native Trapper's Compensation Plan will be submitted as part of the Native Affairs Socio-Economic Action Plan. The plan will provide for compensation in the case of a demonstrated reduction in trapping harvest as a result of project activity. A project employee will be designated as a Claims Officer who can assist with completion of claim forms and who will be responsible for processing claims.

6.0 PUBLIC PARTICIPATION

This section briefly summarizes the scope and results of the public participation program being carried out by Alberta-Pacific. Details of the program are presented in a separate document.

6.1 PROGRAM SCOPE AND ELEMENTS

The public participation program was designed to provide for two-way dialogue between Alberta-Pacific and the people affected by the project, namely:

- o pulp mill area residents
- o other rural residents
- o town residents
- o native communities
- o environmental groups
- o local governments.

The program included not only those people within daily commuting distance of the mill site, but also those who would be affected by the woodlands operations in the Forest Management Area. Also, downstream users of the Athabasca River were included because it was expected that they would have concerns about the potential effects of treated effluent discharges.

With these considerations in mind, a preliminary design for the public participation program was developed. The elements of the program were:

- o meetings with community leaders around the mill site
- o meetings with the mill site community
- o open houses in communities around the mill site
- o meetings with downstream water users
- o meetings with FMA communities

- o meetings with local health units
- o technical workshop at Athabasca University
- o public meetings to review draft EIA
- o business seminars
- o school visitations
- o native participation
- o establishment of liaison offices.

6.1.1 Meetings with Community Leaders (Mill Site Region)

Meetings were held with the leaders of the urban communities within daily commuting distance of the mill site as well as with the County of Athabasca No. 12. At these meetings a presentation was made providing information on the company, the project, infrastructure required, and the plans for environmental protection.

The communities targeted for presentations were Athabasca, Boyle, and Lac La Biche.

6.1.2 Meetings with the Mill Site Community

It was obvious at the outset of the public participation program that, along with the County of Athabasca, the agricultural community within which the mill site is situated would have to be consulted early and often. Of all the communities in the area, it is this one that will experience the most social and economic disruption of the project while the region enjoys the economic benefits.

During the initial meetings with the community approximately 100 households were contacted within a radius of 7 miles of the plant site. The company is in the process of asking the local community to establish a committee for the purposes of:

- o providing input on plans for site development
- o providing feedback during construction
- o facilitating relations during mill operations.

6.1.3 Open Houses

The open house technique was chosen over the public meeting as a means of establishing two-way communication between members of the company charged with the responsibility of building and operating the pulp mill and members of the general public. The open house format provides the opportunity of meeting with the general public on a one-on-one basis so that an effective dialogue can take place. This allows people who may be shy to come forward and voice their concerns in a non-confrontational environment, which is not normally possible in the public meeting style of format. The open house format does not provide the opportunity for people to monopolize the meeting with their own set agendas, thereby allowing as many as possible from the general public to have the opportunity to ask questions and register their concerns.

In the open house format, concerns and questions are recorded by means of both an exit questionnaire and information recorded by each member of the open house team. Answers to questions posed are communicated back to the originator and are included in the EIA document. The information gained through the open house process was used to assist Alberta-Pacific in proposing mitigative measures in the EIA to address the issues of public concern.

Open houses were originally scheduled for Athabasca, Boyle, Grassland, Lac La Biche, Wabasca-Desmarais, and Janvier. Both Plamondon and Fort McMurray were later added to the list due to requests from those two communities and Janvier was deleted since it was covered through a series of meetings in the FMA communities conducted by the Department of Forestry Lands and Wildlife, with participation by Alberta-Pacific personnel.

6.1.4 Meetings with Downstream Water Users

Meetings with downstream water users on the Athabasca River were to be held with Fort McMurray, Fort MacKay and Fort Chipewyan.

6.1.5 Meetings with FMA Communities

As previously mentioned, open houses were originally planned for the FMA communities of Wabasca-Desmarais and Janvier. Although the FMA is not officially part of the environmental impact assessment process for the pulp mill, it was felt that a special effort should be made to communicate with the communities which would be most affected by forestry operations within the first 10 years. Both Fort McMurray and Fort MacKay are within the FMA but are not likely to see any harvesting of trees for at least 10 years.

6.1.6 Meetings with Local Health Units

Meetings with the boards and staff of the local health units in Athabasca and Fort McMurray were identified as requirements of the EIA process. Concerns were expected to be focussed upon treated effluent discharge into the Athabasca River.

6.1.7 Technical Workshop at Athabasca University

A technical workshop was held in Athabasca to discuss the latest developments in technology with respect to the design of bleached kraft mills, with particular focus upon environmental factors. Experts from Sweden and Canada were involved and members of the public, as well as environmental groups, participated.

6.1.8 Public Meetings to Review Draft EIA

Following the release of this Draft EIA, a series of public meetings will be held to allow Alberta-Pacific to respond to remaining public questions and concerns. Any additional mitigative measures will be based in part upon the concerns raised at these public meetings and at meetings which will be held with community leaders.

6.1.9 Business Seminars

A program of business seminars was planned in order to present information on business opportunities, bidding procedures, and purchasing policies for both construction and operations. These seminars are on-going in Athabasca, Boyle, Lac La Biche and Edmonton every 3 to 4 months.

6.1.10 School Visitations

As part of a local training program, school visitations are being made to high schools in the Athabasca/Lac La Biche region in which the graduating classes are given information about training opportunities for 100 to 150 students from the area to enroll in a one to two year training program in pulp mill technology possibly at an Alberta technical college.

6.1.11 Native Participation

Special meetings are being held with Native communities, Native economic development corporations and Native businessmen to identify opportunities for Native training, employment and business opportunities. Details on Native participation and programs are provided in Appendix 6 of this report.

6.1.12 Establishment of Liaison Offices

Alberta-Pacific has established 11 information liaison offices: two in Lac La Biche and one each for Athabasca, Boyle, Grassland, Calling Lake, Wabasca-Demaraais, Janvier, Kikino Settlement, Peerless Lake and Wandering River/Plamondon. The coordinators meet bi-weekly. The company has also established a toll-free information number: 1-800-642-3801.

6.2 RESULTS OF OPEN HOUSES

6.2.1 Grassland

An estimated 200 people attended the Grassland open house. Forty-three questionnaires were returned as well as a number of written questions from people living within the immediate area surrounding the mill site. The major issues of concern related to lifestyle change, air emissions, and reforestation. Also mentioned were concerns over liquid effluent, noise, traffic, health, hunting/fishing/trapping, groundwater, future generations, project size and the social impact during construction.

The major benefits from the project were viewed as employment, more people and a better economy.

6.2.2 Boyle

An estimated 180 people attended the Boyle open house, of whom 60 returned questionnaires for a response rate of 33%. Major concerns expressed by those completing the questionnaire were lifestyle change, social impact during construction, liquid effluent, reforestation and traffic. Also mentioned were concerns over hunting/fishing/trapping and air emissions.

The major benefits from the project were viewed as employment, a better economy and more people. Other benefits mentioned included a better standard of living and new business opportunities.

6.2.3 Lac La Biche

An estimated 200 people attended the open house portion and a further 200 people attended the public meeting portion. Thirty-three people filled out questionnaires. The major issues of concern related to hunting/fishing/trapping, reforestation, liquid effluent and air emissions. Other issues of concern included lifestyle change, tourism, future generations, health and the Athabasca watershed.

The major benefits were perceived as being more employment and a better economy.

6.2.4 Athabasca

Of the estimated 400 people who attended the Athabasca open house, 93 filled in the questionnaire for a response rate of 23%. The major issues of concern related to liquid effluent, lifestyle change, reforestation, air emissions, inflation and hunting/fishing trapping. Other concerns included the social impact of construction, traffic, tourism, Athabasca watershed, job training/employment and spills.

The major benefits of the project were viewed as employment, a better economy and more people.

6.2.5 Fort McMurray

An estimated 150 people attended the Fort McMurray open house. Twenty-six questionnaires were completed. The major issues of concern were liquid effluent, air emissions, the Athabasca watershed and reforestation. Other concerns related to the project size, the kraft process and wildlife.

The major benefits from the project were seen to be employment and a better economy.

6.2.6 Plamondon

An estimated 100 people attended the Plamondon open house, of whom 27 returned a completed questionnaire. The major issues of concern related to water effluent and air emissions. Other concerns raised included reforestation, job training/employment, project size, the kraft process and wildlife.

The major benefits of the project were viewed as employment, more people and a better economy.

6.2.7 Summary

An estimated 1230 people attended the 6 open houses and 282 people completed the questionnaire (response rate of 23%). The major issues of concern were liquid effluent (18%), air emissions (14%), lifestyle change (12%) and reforestation (11%). Other issues identified included hunting/fishing/trapping, inflation, social impact of construction, traffic and the Athabasca watershed.

The major benefits of the project were seen as employment (44%), a better economy (16%) and more people (15%). Other benefits identified included the use of the wood resources and a better standard of living.

The following pages summarize the environmental and socio-economic concerns and potential impacts identified in the EIA, as well as Alberta-Pacific's proposed mitigation strategies. Together, these mitigation measures comprise Alberta-Pacific's environmental protection plan, which is designed to minimize the adverse environmental and social impacts of the pulp mill project. The summary pages include topic by topic references to specific sections of the main EIA text that can be consulted for additional information.



ENVIRONMENTAL PROTECTION PLAN

PROJECT PHASE: PLANNING DESIGN
IMPACT TYPE: SOCIO-ECONOMIC

CONCERN	POTENTIAL IMPACT	MITIGATION MEASURE	EIA SECTION
P.1 Environmental impact of the project upon Spruce Valley/Sandy Ridge community.	Considerable concern about the impact of the pulp mill upon human health and upon livestock	Answer questions and concerns about human health in writing to mill site area residents. Sponsor a Technical Workshop at Athabasca University with world renowned experts.	3.4 (DOC.#2)
P.2 Impact of mill construction and operation upon farms/residences within 1/2 mile of the mill site.	Concerns about groundwater integrity, noise, social impact from camps, traffic, etc.	Consider obtaining options to purchase land within 1/2 mile of the mill site. Potential for leasing land back to neighbouring farms for agricultural use.	5.5.2
P.3 Road closures and the location of new roads.	Local road network altered resulting in traditional communication patterns being disrupted. New highways serve farms in the area.	Work with the county and the pulp mill area residents' committee to effect a suitable road closure plan and new road plan to minimize the impact due to road closures and industrial traffic.	5.5.2
P.4 Location of outfall line.	Disruption of farming activities during construction of effluent line	Review proposed effluent line route with local land owners to select a route which will minimize disruption to farming operations.	5.5.2
P.5 Education needs/medical needs.	Additional students may require new schools. Additional population may require new hospital beds.	Share projections of students and need for hospital beds with appropriate educational and medical authorities. Training programs at Athabasca University.	5.3.5 5.3.6
P.6 Housing/land development needs due to the project.	Additional residents will require new housing.	Share housing needs with area municipalities through presentations/open houses.	5.3.4
P.7 Disruption of local groundwater during construction/operation.	Possible contamination of groundwater during construction of pulp mill and during operations (e.g. effluent ponds, chemical spills, etc.).	Work with the County and the pulp mill area residents to set up a groundwater monitoring program and a contingency plan in the unlikely event of contamination.	4.1.6

ENVIRONMENTAL PROTECTION PLAN

PROJECT PHASE: CONSTRUCTION
IMPACT TYPE: AQUATIC

CONCERN	POTENTIAL IMPACT	MITIGATION MEASURE	EIA SECTION
C.1 Effects of increased suspended solids loading in Athabasca River and possible contamination of Deer and Bear creeks due to surface disturbance or fuel spills.	- o Impact of increased sediment on invertebrate population and on fish. - o Pollution of water used by cattle.	- o Provide fuel storage area to provide for complete containment of spills. - o Prevent uncontrolled surface runoff from entering watercourses (use of vegetative buffer zones, berms, ditches, etc.). - o Water quality monitoring in Athabasca River, Deer Creek and Bear Creek with remedial action if required.	4.1.3.19 4.1.7
C.2 Groundwater contamination as a result of construction activities.	Contamination of groundwater and local water wells.	o Design fuel storage area to be impermeable and to provide for spill containment.	4.1.6
C.3 Disposal of waste from construction of mill and associated infrastructure.	Contamination of surface or groundwater.	- o Solid waste will be incinerated or landfilled onsite in a manner approved by Alberta Environment. - o Sanitary waste will be treated.	3.4.1

ENVIRONMENTAL PROTECTION PLAN

PROJECT PHASE: CONSTRUCTION
IMPACT TYPE: ATMOSPHERIC

CONCERN	POTENTIAL IMPACT	MITIGATION MEASURE	EIA SECTION
C.4 Dust during construction of mill and associated infrastructure.	Inconvenience to area residents.	Controlled on access roads by oiling or application of calcium chloride; controlled on site by calcium chloride.	

ENVIRONMENTAL PROTECTION PLAN

PROJECT PHASE: CONSTRUCTION
IMPACT TYPE: TERRESTRIAL

CONCERN	POTENTIAL IMPACT	MITIGATION MEASURE	EIA SECTION
C.5 Soil erosion and soil loss during construction of mill and associated infrastructure.	Wind and water erosion due to loss of vegetation and topsoil disturbance; bank erosion at riverside facilities.	- o Stockpiling of topsoil, where possible, for re-use in landscaping and reclamation. - o Stockpiling to clay materials for use as lagoon liner. - o Revegetation of disturbed soils and soil stockpiles. - o Implement other erosion control measures as required.	4.3.1
C.6 Bank erosion at riverside facilities	Increased sedimentation in Athabasca River	o Armour river banks as necessary at intake and outfall locations.	4.3.1
C.7 Disturbance of wildlife on mill site and surrounding area during construction of project.	- o Increased possibility of bear-human conflicts. - o Disturbance of wildlife and habitat on or adjacent to Registered Trapping Areas.	- o Education of public concerning bears through use of "bear country" pamphlets, etc. - o Compensation of trappers adversely affected by the mill operations (see also C.11)	4.3.3 4.3.4
C.8 Disturbance of agricultural activities during construction.	Disturbance to agricultural land, loss of access to some agricultural areas, disruption of agricultural operations on farms.	- o Upgrading and additions to road network to ensure continued access to all agricultural land. - o Utility relocation to service remaining farmsteads.	4.3.4
C.9 Loss of production from Agricultural land.	Loss of agricultural land within mill site and buffer zone.	o Return unused portions of the buffer zone to agriculture.	4.3.4

ENVIRONMENTAL PROTECTION PLAN

PROJECT PHASE: CONSTRUCTION
IMPACT TYPE: NATIVE AFFAIRS

CONCERN	POTENTIAL IMPACT	MITIGATION MEASURE	EIA SECTION
C.10 Desire to maximize opportunities for Native Businesses to benefit from project. a) helping Native businesses prepare bids. b) measures to assist native contractors.		- o Preparation of a project industrial and service list. - o Familiarization visits to mill site by Native community leaders. - o Preparation of a list of Native businesses. - o Periodic summaries of Native opportunities. - o Establishment of toll-free long distance telephone service. - o Encourage formation of new businesses and joint ventures that involve Native people. - o Fragmentation of project requirements into units of a size that Native businesses can supply. - o Assistance will be provided by Alberta Pacific to Native businesses in obtaining financing for contracts related to the project. - o Technical, supervisory and administrative assistance will be provided by Alberta Pacific as appropriate. - o On-the-job training, pre-employment and pre-season training will be provided for Natives by Alberta Pacific during the construction phase of the project. - o Provision of orientation services for Native employees. - o Pro-active native recruiting.	5.6.2

ENVIRONMENTAL PROTECTION PLAN

PROJECT PHASE: CONSTRUCTION
IMPACT TYPE: NATIVE AFFAIRS

CONCERN	POTENTIAL IMPACT	MITIGATION MEASURE	EIA SECTION
C.11 Access to information and opportunities related to construction of mill.	Normal communication systems providing job and business opportunity information may not adequately reach native community.	- o Direct liaison by Alberta Pacific with local and regional native leaders and groups. - o Specific employment/business opportunities brought to attention of native community through direct liaison, advertising campaign, provision of a toll-free telephone information service.	5.6.1
C.12 Need for ongoing consultation between AL-PAC and Native community.		- o Establishment of a regional Native Advisory group to ensure that local concerns regarding all aspects of the project are discussed. - o Provision for a Regional Coordinator and local Native community coordinators who will ensure timely and effective, two way transfer of information.	5.6.1
C.13 Disturbance of local Native activities communities during construction of mill and associated infrastructure.		- o Locate facilities and schedule construction so as not to interfere with Native communities and key resources, as identified by the Native community. - o Control access of Alberta Pacific personnel to Native communities and camps. - o Restrict firearms, hunting, trapping and fishing by Alberta Pacific personnel during construction of the project. - o Control alcohol and illicit drugs at all facilities.	5.6.3
C.14 Disturbance of livelihood of Native trappers.	Loss of habitat, disruption of wildlife, disruption of access to wildlife.	o Develop and implement in conjunction with government and Native community, a Native Trappers Compensation Plan.	5.6.3

ENVIRONMENTAL PROTECTION PLAN

PROJECT PHASE: CONSTRUCTION
IMPACT TYPE: SOCIO-ECONOMIC

CONCERN	POTENTIAL IMPACT	MITIGATION MEASURE	EIA SECTION
C.15 Social impact of construction camp (1400 people) over 1 1/2 years.	Use of local community resources causing overcrowding and social tension (e.g. use of Pine Sands Natural Area, local dances, etc.).	Alberta Pacific and their prime contractor to institute strict rules about construction workforce behaviour off-site. Reported violations may result in dismissal.	5.5.2
C.16 Construction traffic during the first year of site construction.	Use of Spruce Valley road during first year of construction until new access highway built by Alberta Transportation.	Will encourage the use of co-op transportation of construction workers to the site. Will encourage the County to maintain and oil Spruce Valley Road.	5.5.2
C.17 Protection of Groundwater during construction.	Possible disturbance of quantity/quality of groundwater during site excavations.	Drill groundwater monitoring wells. Use of soil cement during site grading. Provision of trucked potable water to affected landowner until quality/quantity restored.	4.1.6
C.18 That benefits during construction are maximized.	Economic benefits to local economies will help to offset impacts during construction.	Union/non-union hiring of labour by major contractors at mill site and Edmonton. All Alberta Pacific personnel hired at mill site. A local business directory will be made available to all major contractors.	5.3.1.1
C.19 Social impact of the project upon local agricultural communities.	Anxiety over the scale and extent of the development and its social impact upon the farming communities.	Work with an area residents committee to improve communications and address local concerns.	5.5.2

ENVIRONMENTAL PROTECTION PLAN

PROJECT PHASE: OPERATIONS
IMPACT TYPE: AQUATIC

CONCERN	POTENTIAL IMPACT	MITIGATION MEASURE	EIA SECTION
O.1 Effects of water removal from Athabasca River.	Decreased flow at critical times of year for downstream area.	Mill designed for minimum water consumption.	4.1.3.1
O.2 Increased B.O.D. in Athabasca River.	Reduced D.O. levels, particularly during under ice conditions, and consequent effects on aquatic life. Impact of all pulp mills on river is of concern.	- Use of state-of-the-art technology in process and effluent treatment to minimize effluent B.O.D. - Simulation of impact of all present and future mills on D.O. levels in river; indicates effects due to addition of CFI mill are acceptable. - Monitoring of effluent and in Athabasca River	4.1.3.2 4.1.7
O.3 Effects of increased suspended solids loading in Athabasca River.	Impact of increased sediment on invertebrate population and on fish.	- Use of secondary effluent treatment with multiple stages of settling to minimize suspended solids. - Monitoring in effluent and Athabasca River	3.2.2 4.1.7
O.4 Organochlorine content of effluent	- Toxicity and long-term persistence in the aquatic environment. - Off-flavours in fish (fish tainting)	- Organochlorine content of effluent reduced by 80% compared to conventional mills through process modifications to reduce chlorine use. - Monitor organochlorine levels in effluent and Athabasca River. - Monitor toxicity	2.4.3 3.2.2 4.1.3.5 4.1.7

ENVIRONMENTAL PROTECTION PLAN

PROJECT PHASE: OPERATIONS
IMPACT TYPE: AQUATIC

CONCERN	POTENTIAL IMPACT	MITIGATION MEASURE	EIA SECTION
0.5 Effect of additions of dioxins, furans on human health and Athabasca River system.	Toxicity of dioxins to fish, mammals, downstream ecosystem and water users.	- o Reduce dioxin release in effluent to non-detectable levels by means of process modifications and use of defoaming chemicals free of dioxin precursors - o Baseline study of dioxins in edible fish near the mill. - o Monitoring of dioxin in mill effluent and in edible fish.	2.4.3, 3.2, 4.1.3.6 4.1.3.6, 4.1.7
0.6 Toxic effects on fish and other aquatic organisms.	Acute (lethal) and chronic (sublethal) toxicity.	- o Secondary effluent treatment. - o Extensive in-plant and out-plant spill controls to prevent spilled materials from entering the river. - o Collection and treatment of contaminated runoff. - o Provision for recycling process upset discharges without upsetting the effluent treatment system. - o Routine bioassays (to detect acute toxicity). - o Benthic biomonitoring program (to detect sublethal toxicity). - o Effluent diffuser to provide rapid dilution.	3.2.2 3.6.2 3.6.1 3.2.2 4.1.3.17 4.1.7 3.2.3

ENVIRONMENTAL PROTECTION PLAN

PROJECT PHASE: OPERATIONS
IMPACT TYPE: AQUATIC

CONCERN	POTENTIAL IMPACT	MITIGATION MEASURE	EIA SECTION
O.7 Aesthetic degradation of the river.	Effects of colour, foam, odour.	- o Colour reduction by oxygen delignification, 70% chlorine dioxide substitution - o Foam removed in defoaming pond. - o Odour reduced by secondary effluent treatment - o Monitoring of colour in effluent and Athabasca River	4.1.3.4 3.2.2 4.1.3.12 4.1.7
O.8 Nutrient enrichment of downstream environment.	Increased phosphorus level in downstream Athabasca River.	- o Benthic monitoring program. - o Phosphorus use will be reduced or phosphorus will be removed in effluent treatment system, if necessary.	4.1.3.9
O.9 Sewage	Bacterial contamination of Athabasca River	- o Treatment of sewage prior to processing through effluent treatment system - o Monitoring of coliform bacteria in effluent and Athabasca River	4.1.3.7 4.1.7
O.10 Damage to two nearby small watercourses.	Flooding, scouring, other physical alterations of two small watercourses that abut mill site.	- o Control of flow to watercourses from storm drainage settling pond. - o Continuing monitoring program with remedial action if necessary.	4.1.3.9 4.1.7
O.11 Effect of contaminated surface runoff on local watershed (Deer and Bear Creeks)	- o Contamination of local watershed runoff from wood handling areas and plant site. - o Polluted creek not useable by cattle as source of drinking water.	- o Collection of contaminated runoff and processing through effluent treatment system. - o Water quality monitoring program.	3.6.1 4.1.7

ENVIRONMENTAL PROTECTION PLAN

PROJECT PHASE: OPERATIONS
IMPACT TYPE: AQUATIC

CONCERN	POTENTIAL IMPACT	MITIGATION MEASURE	EIA SECTION
O.12 Chemical spills in the plant or in chemical delivery and storage areas.	Contamination of surface water or groundwater.	In-plant and out-plant spill containment systems, including an emergency spill pond.	2.6.3 3.6.2
O.13 Effects on groundwater.	- Contamination of groundwater and local water wells. - Reduced water levels in wells.	- Site hardening of soil to prevent infiltration of runoff or spills. - Collection and treatment of contaminated surface runoff. - Lining of effluent treatment lagoons. - Monitoring of groundwater onsite and offsite; remedial action if necessary. - Guarantee of water supply to any affected off-site users.	4.1.6, 4.1.7 4.1.7
O.14 Disposal of solid waste from operation of mill.	Contamination of surface or groundwater.	- Other solid waste will be incinerated for power or landfilled onsite in approved landfills. - Hazardous waste such as chemical drums will be stored on site in a licenced storage facility until shipped to the special waste disposal facility at Swan Hills.	3.4.2

ENVIRONMENTAL PROTECTION PLAN

PROJECT PHASE: OPERATIONS
IMPACT TYPE: ATMOSPHERIC

CONCERN	POTENTIAL IMPACT	MITIGATION MEASURE	EIA SECTION
O.15 Deterioration in air quality due to gaseous pulp mill emissions.	Increased levels of H ₂ S, SO ₂ , NO _x , Cl and ClO ₂ in air, particularly downwind of mill.	- Simulation of emissions in area around mill indicates H₂S, SO₂, NO_x, Cl or ClO₂ emissions will all be below Alberta Environment standards. - Stack emissions and ambient concentrations will be monitored regularly and remedial action taken as necessary.	4.2.3
O.16 Pollution from airborne particulate emissions.	Concerns with particulate matter in flue and tank gases from chemical recovery circuit and power boiler.	Use of electrostatic precipitators and scrubbers prior to venting of gas to atmosphere.	3.3
O.17 Overall, long-term effects of atmospheric emissions.	- Odour, aesthetics, acidification of water-bodies and of soil, etc. - Loss of tourism and associated revenues.	- Monitoring of stack emissions on site, and of SO₂ and H₂S in surrounding region (using a monitoring trailer). Remedial action taken, if necessary. - Use of evaporators, concentrators.	3.3
O.18 Malodorous gas emissions.	Offensive and/or noxious odours in vicinity of mill.	Collection, scrubbing and incineration of gases in either the lime kiln (high volume, low concentration gases) or the recovery boiler (low volume, high concentration).	4.2.3 & 3.3.2
O.19 Noise pollution during normal operation of mill.	Disturbance of surrounding area, people and wildlife; health hazard to employees and local residents.	Controlled on-site at source with silencers and enclosures to meet Alberta Occupational Safety and Health guidelines.	3.5

ENVIRONMENTAL PROTECTION PLAN

PROJECT PHASE: OPERATIONS
IMPACT TYPE: TERRESTRIAL

CONCERN	POTENTIAL IMPACT	MITIGATION MEASURE	EIA SECTION
O.20 Soil erosion during operation of mill and associated infrastructure.	Wind and water erosion due to loss of vegetation; bank erosion at riverside facilities.	- o Revegetation of disturbed soils, including excavated materials. - o Implement other erosion control measures as required.	4.3.1
O.21 Disturbance of wildlife on mill site and surrounding area.	- o Increased possibility of bear-human conflicts. - o Disturbance of wildlife and habitat on or adjacent to Registered Trapping Areas.	- o Installation of bear-proof garbage containers in all recreation areas. - o Education of public concerning bears through use of "bear country" pamphlets, etc. - o Compensation of trappers adversely affected by the project.	4.3.3, 4.3.4
O.22 Loss and disturbance of agricultural land.	Loss of agricultural land, loss of access to some agricultural areas, disruption of agricultural operations on farms where rail or road access bisects fields.	- o Upgrading and additions to road network to ensure continued access to all agricultural land. - o Return unused portions of buffer zone to agriculture. - o Consider returning unused portions of mill site to agriculture.	4.3.4
O.23 Loss of or damage to historical resources.		- o No historical resources were found to be present on mill site or access corridors. - o Lac La Biche Mission site will not be affected	4.3.5

ENVIRONMENTAL PROTECTION PLAN

PROJECT PHASE: OPERATIONS
IMPACT TYPE: NATIVE AFFAIRS

CONCERN	POTENTIAL IMPACT	MITIGATION MEASURE	EIA SECTION
O.24 Desire to maximize opportunities for Native Businesses to benefit from project. a) helping Native businesses prepare bids. b) measures to assist native contractors.		- o Preparation of a project industrial and service list. - o Familiarization visits to mill site by Native community leaders. - o Preparation of a list of Native businesses. - o Periodic summaries of Native opportunities. - o Establishment of toll-free long distance telephone service. - o Encourage formation of new businesses and joint ventures that involve Native people. - o Fragmentation of project requirements into units of a size that Native businesses can supply. - o Assistance will be provided by Alberta Pacific to Native businesses in obtaining financing for contracts related to the project. - o Technical, supervisory and administrative assistance will be provided by Alberta Pacific as appropriate. - o On-the-job training, pre-employment and pre-season training will be provided for Natives by Alberta Pacific. - o Provision of orientation services for Native employees. - o Provision of counselling services for Native employees (financial, training, career planning, etc.). At least one counsellor will be able to discuss concerns with Native employees in their own language. - o Pro-active native recruiting.	5.6.2 5.6.2

ENVIRONMENTAL PROTECTION PLAN

PROJECT PHASE: OPERATIONS
IMPACT TYPE: NATIVE AFFAIRS

CONCERN	POTENTIAL IMPACT	MITIGATION MEASURE	EIA SECTION
O.25 Disturbance of local Native activities communities during operation of pulp mill.		- Control access of Alberta Pacific personnel to Native communities and camps. - Control alcohol and illicit drugs at all Alberta Pacific facilities.	5.6.3
O.26 Disturbance of livelihood of Native trappers.	Loss of habitat, disruption of wildlife disruption of access to wildlife.	Develop and implement in conjunction with government and Native community, a Native Trappers Compensation Plan.	5.6.3
O.27 Access to information and opportunities related to operation of mill.	Normal communication systems providing job and business opportunity information may not adequately reach native community.	- Direct liaison by Alberta Pacific with local and regional native leaders and groups. - Specific employment/business opportunities brought to attention of native community through direct liaison, advertising campaign, provision of a toll-free telephone information service.	5.6.1
O.28 Need for ongoing consultation between AL-PAC and Native community.		- Establishment of a regional Native Advisory group to ensure that local concerns regarding all aspects of the project are discussed. - Provision for a Regional Coordinator and local Native community coordinators who will ensure timely and effective, two way transfer of information.	5.6.1

ENVIRONMENTAL PROTECTION PLAN

PROJECT PHASE: OPERATIONS
IMPACT TYPE: SOCIO-ECONOMIC

CONCERN	POTENTIAL IMPACT	MITIGATION MEASURE	EIA SECTION
O.29 Maximize use of regional labour force at the mill during operations.	Lower the overall impact of the project (population, housing, etc.) by employing local people.	Alberta Pacific expect to hire and train over 2 years 100-150 graduating high school students and others for eventual employment at the mill.	5.3.1.2
O.30 Possible groundwater contamination due to accidents (e.g. leaking effluent ponds, spills, etc.).	Contamination of the wells used by neighbouring farmers/residents by drinking water.	Continue to monitor the groundwater quality. Notify neighbours of any groundwater pollution. Truck in fresh water until any problems are corrected.	4.1.6
O.31 Unforeseen impacts upon the local agricultural community.	Unexpected problems which could development during the operation of the mill.	Continue meeting regularly with a mill site residents committee to discuss matters of mutual concern.	5.5.3
O.32 Chemical spills on site or on highways/railroads in the vicinity of the pulp mill.	Localized chemical spills requiring containment, clean-up and possible temporary evacuations.	In conjunction with the Railway and Alberta Transportation, prepare/review/get acceptance from provincial government of a chemical spill contingency plan.	
O.33 Re-establishment of local agricultural community following construction period.	A very much changed agricultural community as a result of building of the pulp mill and associated infrastructure.	Alberta Pacific to work with the mill site community to identify a worthwhile community project and to assist in the organization/fundraising/building/operation of the community project.	5.5.3

APPENDIX 1 AQUATIC IMPACTS

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1.0 HYDROLOGY

1.1 EXISTING FLOWS

The main water body that will be affected by the proposed new mill is the Athabasca River. The proposed mill site is only some 50 km downstream of the Water Survey of Canada gauging station on the Athabasca River at Athabasca, and since no major tributaries intervene, the Athabasca data can be taken as representative of the river at the project site. Historical streamflow data for Athabasca, which are available for the periods 1913 to 1930 and 1938 to date, are compared with data from other Athabasca River gauging stations in Table 1.1.

Table 1.1 Athabasca River discharge (m^3/s).

Month	Condition	Hinton (7AD2)	Windfall (7AE1)	Athabasca (7BE1)	Fort ^a McMurray (7DA1-7CD1)
January	ice	35.5	53.7	96.0	129
February	ice	31.4	50.2	90.0	117
March	ice	30.9	48.7	96.3	120
April	break-up	42.3	103	324	395
May	open	166	303	688	861
June	open	501	664	1030	1164
July	open	475	640	995	1270
August	open	348	454	683	826
September	open	215	296	487	657
October	open	119	184	315	478
November	freeze-up	58.9	93.6	186	262
December	ice	42.2	65.1	119	143
Mean		173	336	436	551

a above Clearwater River confluence, obtained from difference of stations 7DA1 and 7CD1.

The lowest flows normally occur under ice during the period December through March. Discharge increases sharply in April toward a peak in June or July, and then decreases gradually toward the low flow period. The minimum and maximum recorded discharges at Athabasca are 42.2 and 5440 m^3/s .

There are two intermittent watercourses in the vicinity of the mill (Figure 5.1). One, locally known as Bear Creek, flows northeast past the west side and through the northwest corner of the mill site before entering the Athabasca River nearly due north of the mill site. This stream drains a series of three lakes, the last of which is a short distance west of the mill site. The second stream, locally known as Deer Creek, flows northeast from the east side of the mill and enters the Athabasca River approximately 2 km east of the Pine Sands Natural Area boundary. No background data are available on flows in these watercourses.

1.2 IMPACTS ON FLOWS

Water for use in the mill will be obtained entirely from the Athabasca River. Peak water withdrawals will be $1.55 \text{ m}^3/\text{s}$, or 3.7% of the lowest recorded flow and 1.6% of average winter flows. Of the water withdrawn, 90% or $1.4 \text{ m}^3/\text{s}$ will be returned to the river some 5.5 km downstream from the intake structure. The net loss of $0.15 \text{ m}^3/\text{s}$ corresponds to only 0.37% of the lowest recorded flow and 0.16% of the average winter flow. The effects of the proposed mill on Athabasca River discharges are therefore considered to be insignificant.

Groundwater and surface flows from the mill site currently contribute to flows in two intermittent watercourses. Site hardening, runoff collection and diversion of some surface runoff to the effluent treatment system will have the following effects on runoff from the mill site:

- groundwater flows will be greatly reduced
- surface runoff will increase
- overall runoff to local watercourses will decrease.

It is unknown whether water yield in the local streams will be materially affected by these changes; however, the mill site represents only a small portion of their drainage basin areas, particularly in the case of the stream to the west, and potential effects are therefore expected to be slight. The potential for flooding in local watercourses due to high volumes of storm water or snow melt runoff from the millsite will be minimized by controlling the rate of outflow from the storm drainage settling pond.

The portion of the local watercourse (Bear Creek) that passes through the northwest corner of the mill site will not be disturbed by development as no facilities are planned for this area.

2.0 SURFACE WATER QUALITY

2.1 EXISTING SURFACE WATER QUALITY

Existing water quality conditions in the Athabasca River basin were reviewed in considerable detail by Alberta Environment (Hamilton et al. 1985). The survey was based on historical water quality data from three permanent stations (Jasper, Athabasca and Fort McMurray), plus six surveys carried out at several locations within the watershed in 1984-85. Hamilton et al. (1985) described three water quality zones in the Athabasca basin, with Athabasca occurring within the intermediate zone. In this stretch of river, water quality characteristics gradually change from foothills typology to that of the lower basin. Alkalinity and hardness levels decrease while concentrations of suspended solids, metals, nutrients and carbon increase.

Water quality varies seasonally, the high flows of May, June and July being the major controlling factor. Sediment and runoff related particulate parameters occur in the highest concentrations during this period, while major ion and carbon concentrations are maximal during the fall and winter low flow period (Hamilton et al. 1985). Seasonal trends in selected water quality parameters in the Athabasca River are shown in Table 2.1.

No water quality information is available for the small watercourses near the millsite.

Table 2.1 Seasonal variations in mean concentrations of selected Athabasca River water quality parameters and temperature (°C) at Athabasca.

	Suspended Solids (mg/L)	Sodium ^a (mg/L)	Chloride (mg/L)	Sulphate (mg/L)	Colour ^a (units)	Temperature (°C)
January	1.6		5.0	42.1		0.4
February	2.9	31	5.7	43.5	22	0.5
March	2.1		10.0	41.9		0.5
April	114.0		5.4	33.0		2.1
May	70.5	9	2.0	19.3	36	9.4
June	198.0	5	1.3	17.8	52	14.5
July	247.0	17	1.5	16.0	33	17.0
August	64.4		1.3	17.2		16.7
September	40.7	20	1.8	20.1	27	12.1
October	7.9	21	2.1	24.8	26	7.2
November	10.5		3.2	29.2		1.1
December	3.6		4.2	38.5		0.6

^a Based on 1984/85 only (Hamilton et al. 1985).

2.2 SURFACE WATER QUALITY IMPACTS

2.2.1 Introduction

Water quality assessments are primarily concerned with low flow periods because low flows allow the least dilution of effluent discharges. In the case of dissolved oxygen analysis in Northern Alberta, the situation is compounded as the Athabasca River typically has an ice cover during low flow events which limits the extent of reaeration. For this assessment, the one in ten year return period low flow event is used; a 7 day duration is used to allow for the coincidence of these low flows throughout the system. This design event is termed the 7Q10.

In addition to knowing the conditions during an extreme low flow event, it is also useful to know the conditions which will prevail during more typical low flow periods. The one in two year return period 7 day duration low flow event (i.e. the 7Q2) will be used in this report. Values for the 7Q10 and 7Q2 flows at the various

points in the system are presented in Table 2.2. These were determined using a Pearson III distribution for frequency analyses of the available low flow data up to the winter of 1987/88.

Table 2.2 Seven day low flows (m^3/s) in Athabasca River system.

Location	Years of Data	7Q10	7Q2
Athabasca River at Hinton	55	16.4	22.1
Athabasca River at Windfall	18	28.9	36.7
Athabasca River at Athabasca	53	53.4	75.8
Athabasca River upstream of Fort McMurray	28	79.2	100.3
Lesser Slave River at Highway 2A	47	11.6	22.8
Pembina River at Jarvie	27	1.45	3.16

The distribution of flow throughout the system must also consider the contributions made by ungauged tributaries and lateral inflow due to small creeks and, in some areas, groundwater discharge. This hydrologic analysis used the results of Alberta Environment's 1988 winter flow monitoring program wherever possible to apportion normally ungauged flows. Where no data were available, flows were apportioned between the gauged mainstem stations based on drainage area. Lateral inflow and ungauged flows were concentrated at major tributaries (Figure 2.1).

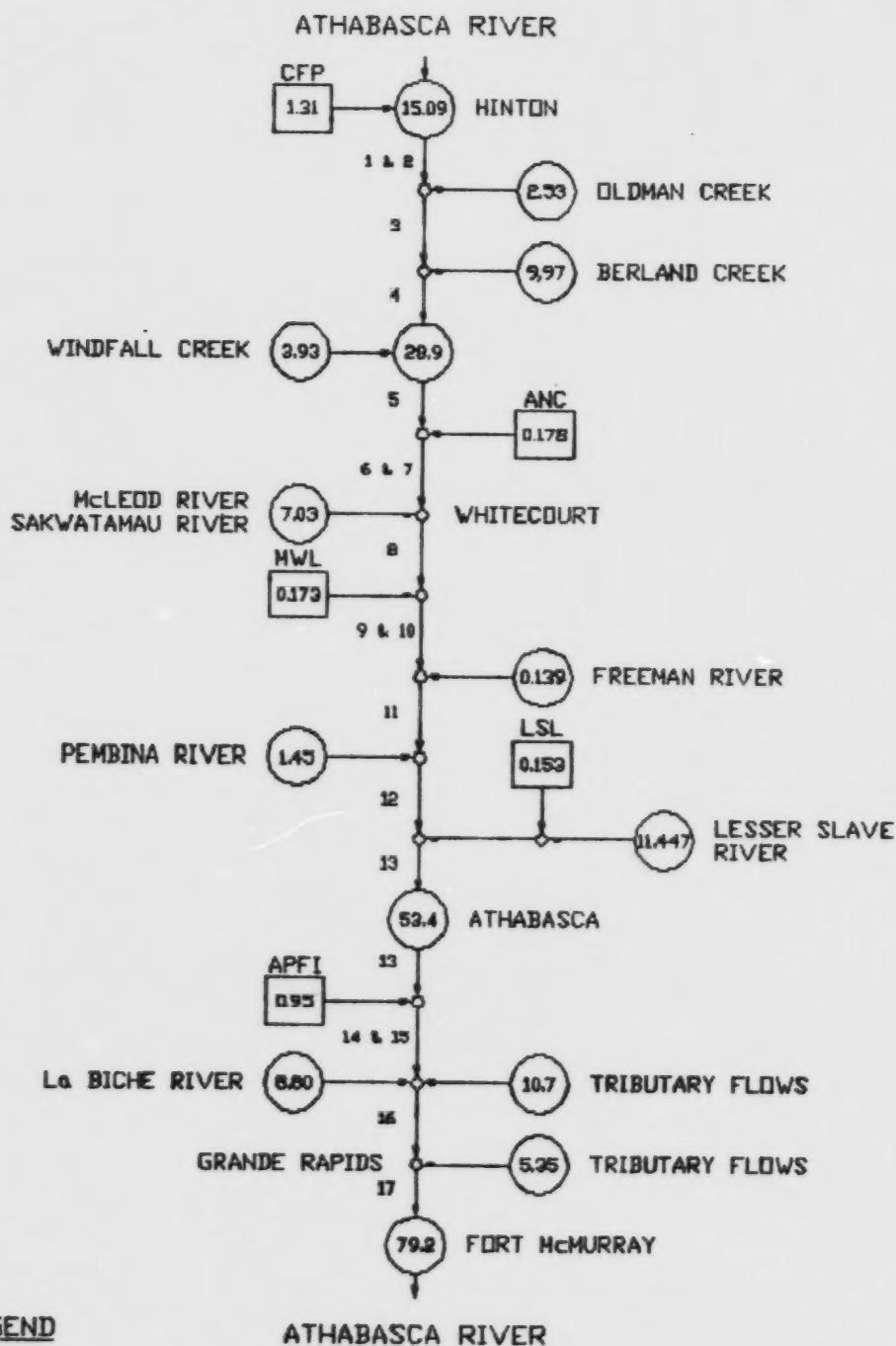


FIGURE 2.1

D.O. MODEL SCHEMATIC
& 1:10 YEAR 7 DAY LOW FLOWS
IN THE ATHABASCA RIVER BASIN

2.2.2 Dissolved Oxygen

Modelling was carried out to simulate dissolved oxygen (DO) and biochemical oxygen demand (BOD) profiles along a 940 km length of the Athabasca River, from Hinton to just upstream of Fort McMurray. Simulations were carried out for a number of effluent loading and river flow scenarios. The model considered the permitted BOD loadings from an expanded Champion Forest Products Ltd. (CFP) pulp mill and a new Millar Western Pulp Ltd. (MWL) pulp mill, both of which are under construction. Additional loadings from the proposed Alberta Newsprint Company (ANC) newsprint mill and a potential mill near Lesser Slave Lake (LSL) were also considered to assess their interactions with the proposed Alberta-Pacific mill. The loadings assumed in this analysis are indicated in Table 2.3.

Table 2.3 Anticipated loading scenario for Athabasca River.

Mill	Capacity (t/d)	Loading Rate (kg/t)	Flow Rate (m ³ /s)	Comment
CFP	1100	7.0	1.31	permit limit
ANC	700	3.0	0.178	anticipated permit
MWL	680	7.5	0.173	permit limit
APFI	1500	5.0	0.95	new source standard (Kraft mills)
LSL	600	3.0	0.153	assumed

The sources of information used for various aspects of the dissolved oxygen model include various Alberta Environment reports (Hamilton et al. 1985, HydroQual 1987, HydroQual et al. in prep.), and environmental impact assessments for the CFP expansion (Stanley 1987), the MWL mill (Simons 1986), and the ANC mill (NLK 1988).

Modelling methods and parameters for the model were reviewed in detail and were also based on recent water quality monitoring field programs conducted by Alberta Environment during February and March 1988. The river flows used in the models (7Q10 and 7Q2) are the lowest average seven day flows occurring once

every ten years and two years, respectively. As noted earlier, these flows generally occur in winter, under ice, when the rate of reaeration in the river is lowest. The river hydraulics were based on the work of HydroQual (1987), Kellerhals et al. (1972) and field work carried out by Stanley during August 1988 in the vicinity of APFI's proposed outfall site.

Background levels for BOD₅ and dissolved oxygen in the tributary streams and for the Athabasca River upstream of Hinton were determined by a review of the NAQUADAT data base, data from the CFP Environmental Impact Assessment, and field trips by Alberta Environment's Consultants and Stanley in 1988 (Table 2.4). Only data for the winter low flow period (January, February and March) were used to determine these values. Median values were selected as the data could not be shown to correlate with the river flows.

Table 2.4 Background DO and BOD₅ levels.

Background DO		
Athabasca River U/S of Hinton	10.9	mg/L
McLeod	7.8	
Berland	10.5	
Freeman	8.8	
Pembina	2.3	
Lesser Slave	12.0	
Others	8.3	
Background BOD₅		
Athabasca River U/S of Hinton	1.30	mg/L
McLeod	1.06	
Berland	1.30	
Freeman	1.60	
Pembina	1.10	
Lesser Slave	1.50	
Others	1.20	

The model parameters for BOD decay and reaeration were refined from the assumptions used by Beak (1988) based on meetings during July 1988 with Dr. Linfield Brown of Tufts University. The theoretical basis for the estimation of BOD decay rate and dissolved oxygen reaeration rates are discussed in the next two sections.

2.2.2.1 BOD Decay Rates

The BOD Equation.

BOD is the most commonly used parameter for measuring the oxygen-depletion characteristics of waste waters. The kinetics of the decay of BOD and the consumption of oxygen is given by the equation:

$$Y = L(1 - \exp(-K_1 \cdot t))$$

where:

Y = the BOD exerted at any time t (mg/L)

L = the ultimate or total BOD present at time 0 (mg/L)

K₁ = the decay rate constant (day⁻¹)

t = time (days)

Typical decay rate values are given in Krenkel and Novotny (1980) in Table 2.5. It can be seen that the decay rate is variable and depends largely on the degree of treatment. From this, it might be concluded that the decay rate for a pulp mill effluent would be in the order of 0.15 day⁻¹ at 20°C.

Table 2.5 Typical BOD decay rate coefficients.

Substance	K ₁ (day ⁻¹)
Untreated Sewage	0.35 - 0.65
High-rate filters and anaerobic contact	0.28 - 0.51
High-degree biological treatment effluents	0.14 - 0.23
Rivers with high pollution	0.28 - 0.69
Rivers with low pollution	0.09 - 0.23

- NOTES:
1. From Krenkel and Novotny (1980).
 2. K₁ values are for base e equation at 20°C.

Temperature Effects

Temperature significantly affects the reaction rate of most biochemical processes. The commonly used method to consider temperature effects is to relate the reaction rates at other temperatures to a reference reaction rate at 20°C using the van't Hoff-Arrhenius law:

$$K_T = K_{20}t^{(T-20)}$$

where:

- K_T = the decay rate at temperature T (day⁻¹)
- K_{20} = the decay rate at 20°C (day⁻¹)
- T = the temperature (°C)
- t = the thermal factor

Values for t range from 1.02 to 1.184 (Krenkel and Novotny 1980, Driscoll et al. 1983). Examination of data presented by Hiidenheimo and Wilson (1974) for untreated and treated effluents from a Kraft mill in Finland indicates that a value of 1.1 is reasonable. This means that reaction rates at 0°C would be about 15% of those at 20°C.

Literature Review

Pulp mill wastes have their own unique characteristics and must be evaluated in the context of the wood source, pulp production processes, waste treatment processes and receiving environment conditions. Typical pulp wastes comprise wood sugars, organic acids, alcohols and lignins. The literature was examined to see how researchers had quantified the BOD decay processes for pulp mill effluents.

Raabe (1968) indicated that pulp mill wastes exhibited a 2-stage BOD process:

- the first stage exhibited a rapid decay due to the oxidation of the carbohydrate constituents;
- the second stage exhibited a slow decay due to the decomposition of lignin, by-products and other decomposable organics.

Work by Hiidenheimo and Wilson (1974) on the effluent from a Kraft pulp mill in Finland also suggested the 2-stage BOD decay process for untreated effluent. They indicated that the second stage decay was not due to nitrification processes (the exertion of oxygen demand due to the decay of nitrogen compounds) as the nitrogenous fraction of the untreated effluent was small. They also found that the treated effluent did not exhibit the 2-stage behaviour.

NCASI (1982 and 1985) evaluated BOD kinetics for a number of pulp mill effluents. NCASI (1982) also indicated that the two types of BOD were present in treated pulp mill effluents. The 1982 paper examined eight different models for BOD kinetic processes and found that a single first-order model was not adequate and that a simultaneous dual first-order model (i.e. "easy" and "hard" to decay BOD) gave the best results. The 1985 paper investigated BOD kinetics further. It supported the adequacy of the simultaneous dual first-order model and presented a case for even more complex BOD models.

Limiting this assessment to the simultaneous dual first-order model (which has found some acceptance in all of the references), the following decay parameters have been presented in the literature (Table 2.6):

Table 2.6 BOD decay literature parameters (simultaneous dual first order model).

Effluent	Component 1		Component 2		Source	L1/(L1 + L2) (%)
	K1	L1	K2	L2		
Bleached Kraft Secondary Effluent	0.48	48.7	0.017	370	N C ASI (1982)	12
Bleached Kraft Secondary Effluent	0.45	54.5	0.017	349	N C ASI (1982)	14
Kraft Biological Effluent	0.08	13.2	0.010	14.7	N C ASI (1985)	47
Kraft Biological Effluent	0.03	17.4	0.033	6.0	N C ASI (1985)	74
Unbleached Kraft Secondary Effluent	0.43	136	0.017	273	N C ASI (1982)	33
Groundwood Secondary Effluent	0.36	37.5	0.017	82.8	N C ASI (1982)	31
Kraft Secondary Effluent	0.08	143	0	0	Hiidenheimo (1974)	100
Kraft Effluent and River Water	1.05	33	0.166	65	Raabe (1986)	34

NOTES: 1. K is BOD decay rate (base e) at 20°C (day⁻¹).
2. L is ultimate BOD (mg/L).

Athabasca River Data

Three field programs have been carried out to determine the in-river DO and BOD concentrations and BOD decay rates for the Athabasca River during the low flow period in winter (the critical dissolved oxygen period for northern Alberta rivers), one by CFP and two by Alberta Environment.

CFP operates a bleached kraft pulp mill at Hinton on the Athabasca River. It is CFP's effluent that has been the main point source of oxygen demanding material on the Athabasca River upstream of Fort McMurray. As part of CFP's ongoing monitoring program, BOD and dissolved oxygen conditions in the effluent, upstream of the outfall, and at two locations (8 km and 48 km) downstream of the outfall have been monitored during winter low flow conditions. Thirteen sets of data were obtained over the course of 4 winters. The results were plotted and a dissolved oxygen model was calibrated to the data (Stanley 1987); a one component dual decay rate model was used. This work indicated a decay rate of 0.6 day^{-1} in the first 8 km (the open water reach) downstream of the outfall. The decay rate in the second reach (under ice cover) was found to be 0.1 day^{-1} .

In February 1986, Alberta Environment measured BOD and dissolved oxygen at seven locations up to 60 km downstream of CFP's outfall (HydroQual 1987). HydroQual calibrated a single component single decay rate dissolved oxygen model to the data and found that a BOD decay rate coefficient of 0.81 day^{-1} was representative of the reach.

In February and in March of 1988, Alberta Environment conducted an extensive water quality monitoring program on the Athabasca River from Hinton downstream to Athabasca. Data were measured at 14 locations over a 540 km reach of the Athabasca River downstream of Hinton. Concentrations of parameters relevant to dissolved oxygen analysis (including BOD_5 , dissolved oxygen and temperature) were measured. These data were made available for use in calibrating dissolved oxygen models.

BOD decay rate constants for a single first-order model could be determined from the BOD data for each of the 13 reaches; however, the uncertainty associated with this method was too large to allow this procedure to be meaningful. The only observable trend was that the decay rate was highest near the Hinton outfall and declined as the flow progressed downstream.

Samples of CFP's effluent were obtained during the two field programs. Each time three grab samples and one 24-hour composite sample were analyzed to

determine the BOD₅, BOD₁₀ and BOD₁₄ values. Table 2.7 shows the decay rates obtained from these data (the data were not extensive enough to allow a simultaneous dual first-order model for the effluent component to be developed):

Table 2.7 BOD decay rates for CFP's effluent.

Test	Decay Rate K1 (day ⁻¹)	BOD _u L1 (mg/L)
February 1988	0.27	75
March 1988	0.21	54

NOTES: 1. Decay rates for base e equation at 20°C.

Calibration of BOD Parameters

Several attempts have previously been made to establish BOD decay rate parameters for the existing and proposed pulp mill effluent discharges on the Athabasca River (Stanley 1987, HydroQual 1987, Beak 1988, and Stanley 1988). These efforts led to differing dissolved oxygen model configurations which, in turn, led to differing results when projections of future dissolved oxygen levels in the Athabasca River were made. Dr. L.C. Brown of Tufts University was retained to establish a consensus for modelling dissolved oxygen in the Athabasca River (Brown 1988). Meetings were held in Edmonton on 7 and 8 July to discuss dissolved oxygen processes based on the data collected in Alberta Environment's 1988 field program. These meetings were attended by staff from Alberta Environment's Consultant (HydroQual) and by staff from Stanley.

The consensus of the meetings was that, although the data collected during February and March 1988 are the most comprehensive available, they are inadequate to calibrate the model with complete certainty. However, a model structure was established based on the data available, information in the literature and Dr. Brown's experience; it was concluded that projections based on this model could be made with some degree of confidence. The parameters of mill effluent decay that were determined for the model are indicated in Table 2.8.

Table 2.8 Model parameters for BOD.

BOD Component	Kraft Mills	CTMP Mills	Background
Effluent Component 1 (Rapid):			
Fraction of Total BOD _U (%)	40	33	0
K (day ⁻¹)	0.36	0.20	N/A
BOD _U /BOD ₅	2.0	2.0	N/A
Effluent Component 2 (Slow):			
Fraction of Total BOD _U (%)	60	67	100
K (day ⁻¹)	0.04	0.04	0.04
BOD _U /BOD ₅	5.5	5.5	5.5

The values presented in Table 2.8 represent the consensus of those at the July meetings. The parameters agree well with those presented in Table 2.6 and, from the modelling of the conditions of the Alberta Environment field trip (Figures 2.2 and 2.3 and Tables 2.9 through 2.12), they are supported by the calibration and validation runs. These are the values used in the production runs.

Table 2.9 BOD₅ calibration results for February conditions.

Item	Value
Number of Points	14
Mean Concentration	3.60 mg/L
Average Error	-0.75 mg/L
Average Error	3.2 %
Average Absolute Error	1.25 mg/L
Average Absolute Error	37.3 %

FIGURE 2.2 - MODEL CALIBRATION - FEB/88

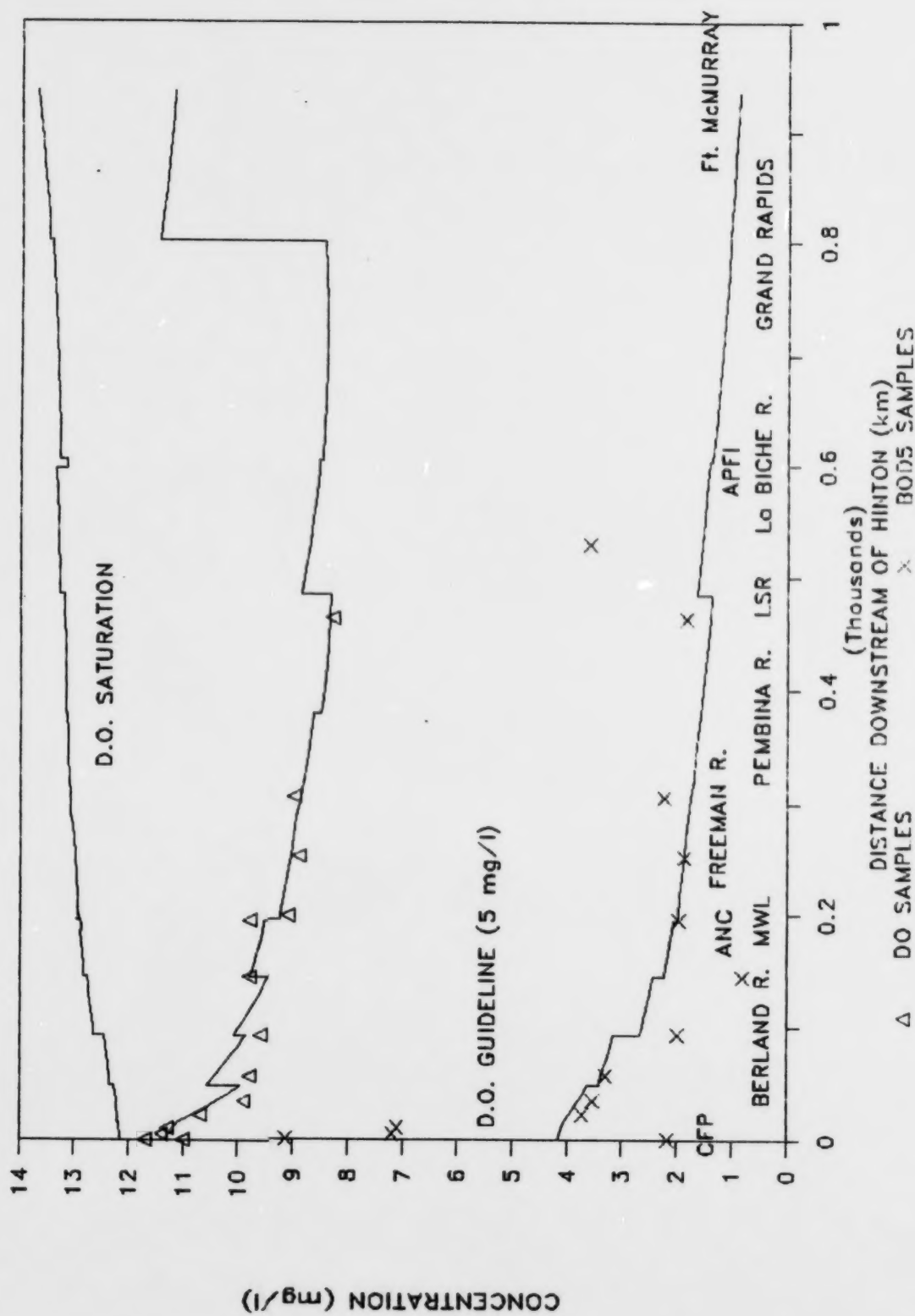


FIGURE 2.3 - MODEL VALIDATION - MAR/88

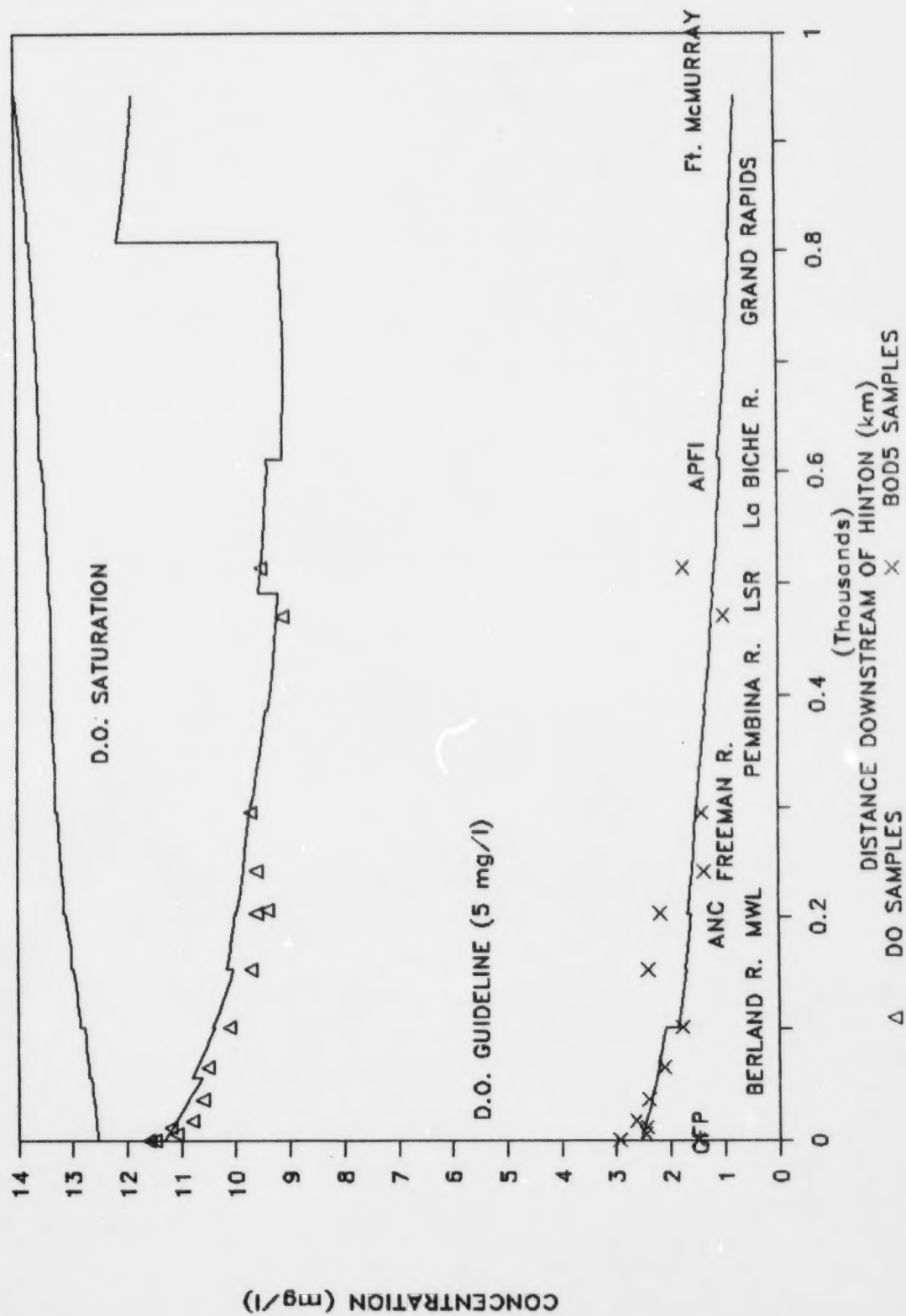




Table 2.10 Dissolved oxygen calibration results for February conditions.

Item	Value	
Number of Points	14	
Mean Concentration	10.02	mg/L
Average Error	0.08	mg/L
Average Error	0.8	%
Average Absolute Error	0.23	mg/L
Average Absolute Error	2.3	%

Table 2.11 BOD₅ validation results for March conditions.

Item	Value	
Number of Points	14	
Mean Concentration	2.02	mg/L
Average Error	-0.10	mg/L
Average Error	-2.2	%
Average Absolute Error	0.35	mg/L
Average Absolute Error	12.6	%

Table 2.12 Dissolved oxygen validation results for March conditions.

Item	Value	
Number of Points	15	
Mean Concentration	10.27	mg/L
Average Error	0.17	mg/L
Average Error	1.8	%
Average Absolute Error	0.22	mg/L
Average Absolute Error	2.2	%

2.2.2.2 Dissolved Oxygen Reaeration Rates

Downstream of each effluent discharge, there will be an open water reach where the river will be naturally reoxygenated during winter. Further downstream, some short reaches of the river remain open even during mid-winter due to high velocity (rapids) or due to the thermal effects of groundwater discharges. Some degree of reaeration will occur in these areas as well.

Calibration

For open water conditions the reaeration rate coefficient is a function of the depth of flow, the velocity and the temperature. Driscoll et al. (1983) outlined a procedure for selecting an appropriate reaeration rate equation (from the equations of Owens, Churchill, and O'Connor-Dobbins). This was the procedure used to determine the open water reaeration rate in the modelling.

The reaeration rate coefficients in the ice-covered reaches were multiplied by a factor (determined by the model calibration) to account for the actual winter conditions. From the February calibration runs, reaeration in the ice covered reaches varied between 0.02 day^{-1} and 0.11 day^{-1} depending on the hydraulic characteristics of each reach. This was estimated by taking a small percentage (in the order of 1% to 8%) of the open water reaeration rate to represent the reaeration rate under ice-cover. For the open water lead downstream of the CFP outfall, it was found that the reaeration rate was about 0.26 day^{-1} .

Based on the above assessment, the dissolved oxygen conditions in the Athabasca River were assumed to be controlled by:

- reaeration rates based on the calibration run percentages; and
- open water leads as indicated in Table 2.13.

Table 2.13 Open water leads.

Mills	Open Water D/S of Mills (km)
CFP	15
MWL, ANC	2
LSL	5
APFI	6

Reaeration in Rapids Downstream of Athabasca

Reaeration processes for rivers are included in the dissolved oxygen model by means of the equations of Churchill, Owen and O'Connor-Dobbins (Driscoll et al. 1983). Although they provide estimates for river reaeration as a function of depth, velocity and temperature, these equations do not account for the additional reaeration that is achieved as the river cascades and flows over waterfalls. This is of importance in the reach of the Athabasca River between Athabasca and Fort McMurray where there are a large number of rapids (Table 2.14).

Laboratory work done by Uchirin et al. (1985) indicates that the reaeration accomplished by cascades and waterfalls is substantial. Tebutt (1972) indicated that cascades significantly increased reaeration efficiency over that for an inclined channel. He also found that, for a given cascade configuration, the reaeration efficiency decreased with increasing flow.

Table 2.14 Rapids downstream of Athabasca.

Station (km)	Name	Classification of Rapids
738	Pelican Rapids	
742	Stony Rapids	
767	Rapids Du Joli	
800	Grand Rapids	VI
805	Little Grand Rapids	III
845	Brule Rapids	IV
880	Boiler Rapids	III
885	Middle Rapids	IV
890	Long Rapids	IV
900	Crooked Rapids	III
901	Rock Rapids	III
905	Little Cascade Rapids	III
910	Cascade Rapids	IV
925	Mountain Rapids	IV

NOTES: Rapid Classifications are:

- I - Clear passages, small regular waves.
- II - Clear passages, medium waves, low ledges.
- III - Narrow clear passages, numerous high irregular waves, log-jams.
- IV - Obstructed passages, high powerful and irregular waves, boiling eddies, rocks.
- V - Extremely obstructed passages, very violent waves, boiling eddies and rocks, unavoidable.
- VI - Extreme risk to life.

Uchrin et al. (1985) measured dissolved oxygen levels upstream and downstream of two waterfalls on the Passaic River in New Jersey. One of the waterfalls was a cascading system with a drop of 11 m and the other was a sheer drop of 21 m. The reaeration data were evaluated in the context of the deficit ratio (R), which is the ratio of the upstream and downstream oxygen deficits:

$$R = \frac{C_s - C_u}{C_s - \bar{C}_d}$$

where

- C_s = the saturated dissolved oxygen level (mg/L),
- C_u = the upstream dissolved oxygen level (mg/L), and
- C_d = the downstream dissolved oxygen level (mg/L).

Uchirin et al. (1985) attempted various correlations of R to the water temperature and the flow rate. If these relations were applied to the Athabasca River they would indicate reaeration to complete saturation; this is not the case for the river.

As the Athabasca River is not fully saturated at Fort McMurray, the NAQUADAT data were examined to provide information on the degree of reaeration that presently occurs. Data for the winter months (January, February and March) only were examined for stations at Athabasca, above Horse River and below Fort McMurray (Table 2.15). The Horse River station is more representative of conditions downstream of the rapids as it does not include flow from the Clearwater River (a major tributary to the Athabasca River at Fort McMurray). As coincident data were only available for two dates, the monthly averages were compared. From these, it can be seen that the dissolved oxygen levels at Athabasca (i.e. above the rapids) are lowest in February and March at about 9.6 mg/L. During these months, the average dissolved oxygen level above Fort McMurray (Horse River confluence) is about 12.7 mg/L (i.e. 3.1 mg/L higher). This reaeration is significant but may not bring the oxygen levels to full saturation (13.9 mg/L) at Fort McMurray.

Consequently, the dissolved oxygen model used in this report has assumed a constant dissolved oxygen increase of 3 mg/L at Grand Rapids to represent the reaeration benefits provided by all of the rapids between Athabasca and Fort McMurray. The Grand Rapids site was selected as it is the most significant cascade, having a drop of about 12 m. As the oxygen deficiency is the primary driving force for reaeration and since the future oxygen deficiencies predicted by the river modelling for the pulp mill activity on the river would be greater than at present, this assumed 3 mg/L dissolved oxygen increase is considered conservative.

Table 2.15 Athabasca River winter reaeration (mg/L dissolved oxygen) through rapids.

Month	At Athabasca		Above Horse River		Below Fort McMurray	
	n	Average	n	Average	n	Average
January	13	11.3	1	11.6	4	12.2
February	10	9.5	3	12.5	4	11.6
March	13	9.7	2	12.9	5	12.3

- NOTES:
1. Levels are averages for all data at the site for the given month.
 2. n is the number of data values considered.

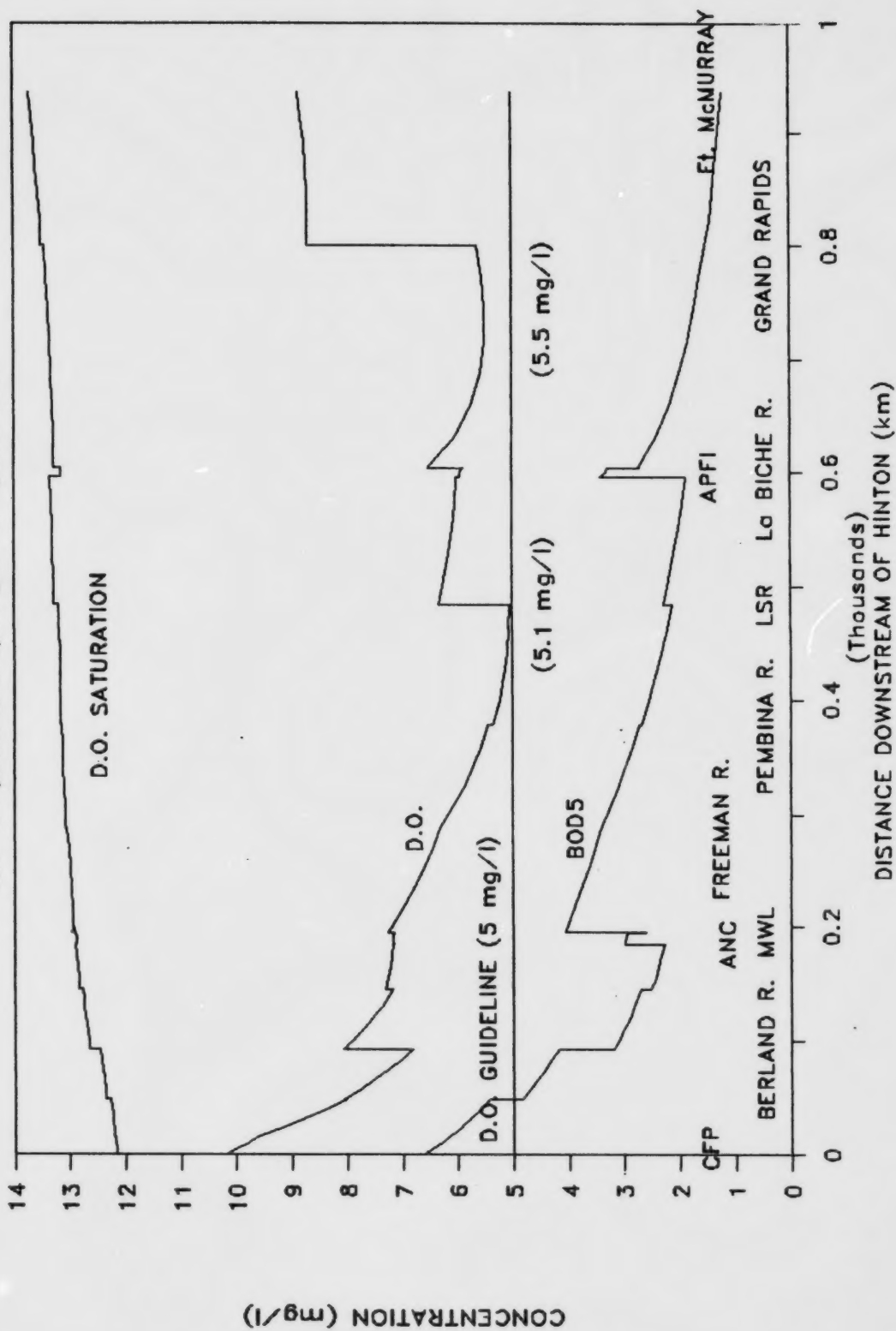
2.2.2.3 Modelling Results

Two loading scenarios are presented in this report. The first (Run 1) involves the inclusion of all known current and potential pulp mill development in the Athabasca River basin, at their anticipated loadings, as presented in Table 2.3. The second (Run 2) differs from the first with the reduction of APFI's loading from 5.0 kg/t to 3.0 kg/t. Both scenarios were run with the 7Q10 design river flows.

Run 1 (Figure 2.4) indicates the potential impact of the anticipated permitted loadings from the CFP, ANC, MWL, LSL and APFI mills during the 7Q10 flow condition. The dissolved oxygen profile decreases from a level of about 10.8 mg/L at Hinton to a low of 5.1 mg/L at the Lesser Slave River where an increase is experienced due to the contribution of LSR. The profile then declines to a low of 5.5 mg/L downstream of APFI where an increase of about 3.0 mg/L is then experienced due to the effects of Grand Rapids. Downstream of Grand Rapids the dissolved oxygen profile remains safely above the DO guideline of 5.0 mg/L.

FIGURE 2.4 - RUN 1 - 7Q10 FLOW

CFP @ 7;MWL @ 7.5;ANC,LSL @ 3;APFI @ 5



Run 2 (Figure 2.5) indicates the potential impact of the anticipated permitted loadings from the CFP, ANC, MWL and LSL mills and a reduced loading (3.0 kg/t) from the APFI mill during the 7Q10 flow condition. Run 2 is identical to Run 1 from Hinton to APFI, at which point the dissolved oxygen profile begins to differ due to the reduced load from APFI. The profile declines to a low of 6.0 mg/L downstream of APFI where again an increase of 3.0 mg/L is experienced due to the effects of Grand Rapids. Downstream of Grand Rapids the dissolved oxygen profile again remains safely above the D O guideline of 5.0 mg/L.

Sensitivity Analysis

The calibration and validation of the D O model is based on matching the results obtained from the 1988 Alberta Environment winter collection program. However, no data were collected downstream of the Lesser Slave River (LSR) confluence in this program. As a result, without data to calibrate to, an accurate estimate of appropriate model parameters between LSR and Fort McMurray cannot be made. The calibration of the D O model for this reach is based on sound hydraulics but only reasonable estimates of the amount of reaeration (K2) that the river undergoes. It was assumed that the calibrated reaeration rate for the reaches just upstream of LSR (in the order of 0.06 to 0.09 L/day) could be applied downstream. This is a fair assumption, but without measured data to calibrate to, it cannot be confirmed. As a result, a sensitivity analysis of the reaeration (K2) in this reach was conducted.

Figure 2.6 shows the sensitivity run to the February 1988 data and Figure 2.7 shows the sensitivity run to the March 1988 data. In both runs when the river reaeration (K2) was reduced to half of its originally calibrated value downstream of LSR, the dissolved oxygen profile downstream of LSR changed from the original calibration and validation (Figures 2.2 and 2.3), but still appeared plausible without data points to match.

FIGURE 2.5 - RUN 2 - 7Q10 FLOW

CFP @ 7:MWL @ 7.5;ANC,LSL,APFI @ 3

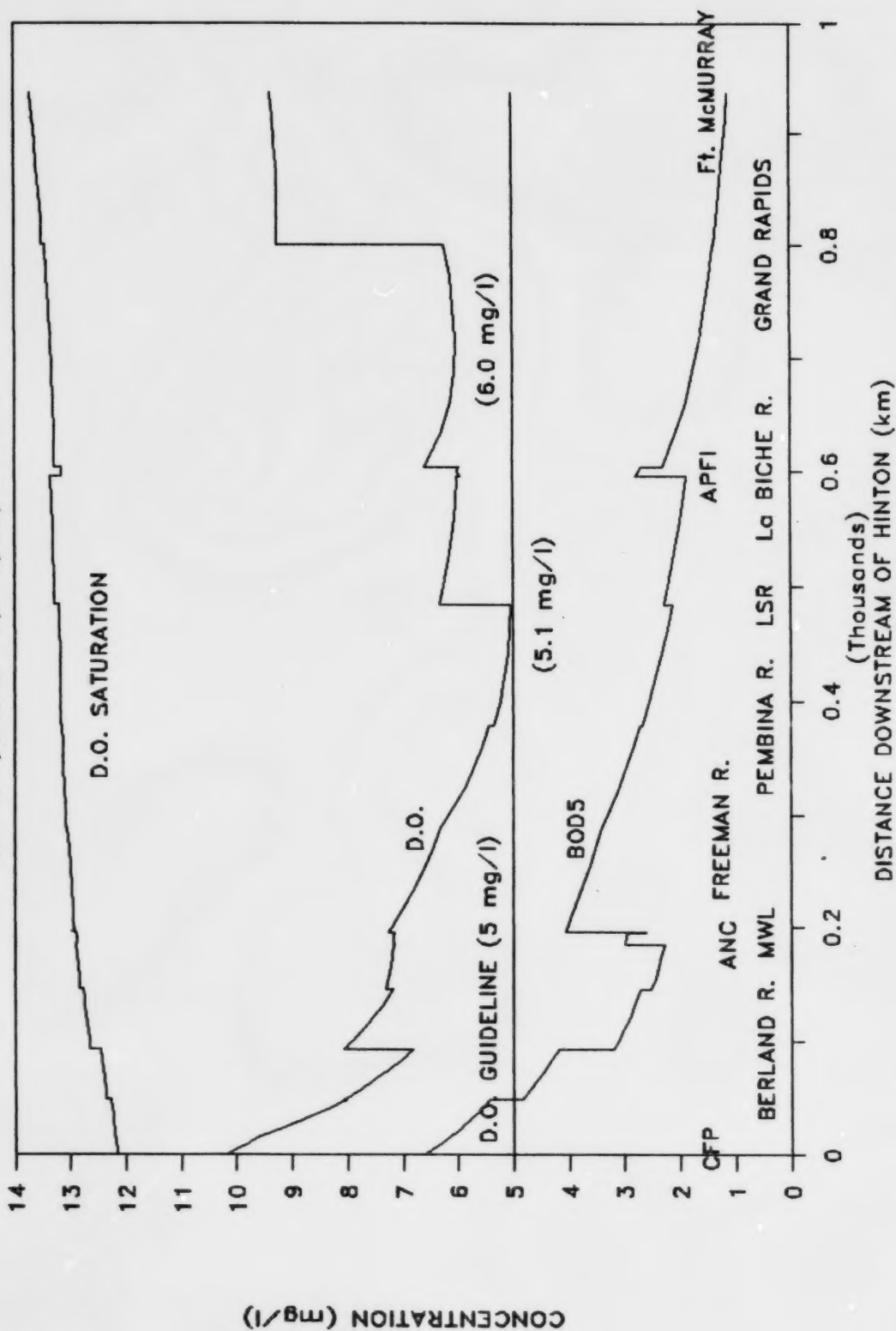


FIGURE 2.6 - SENSITIVITY RUN - FEB/88

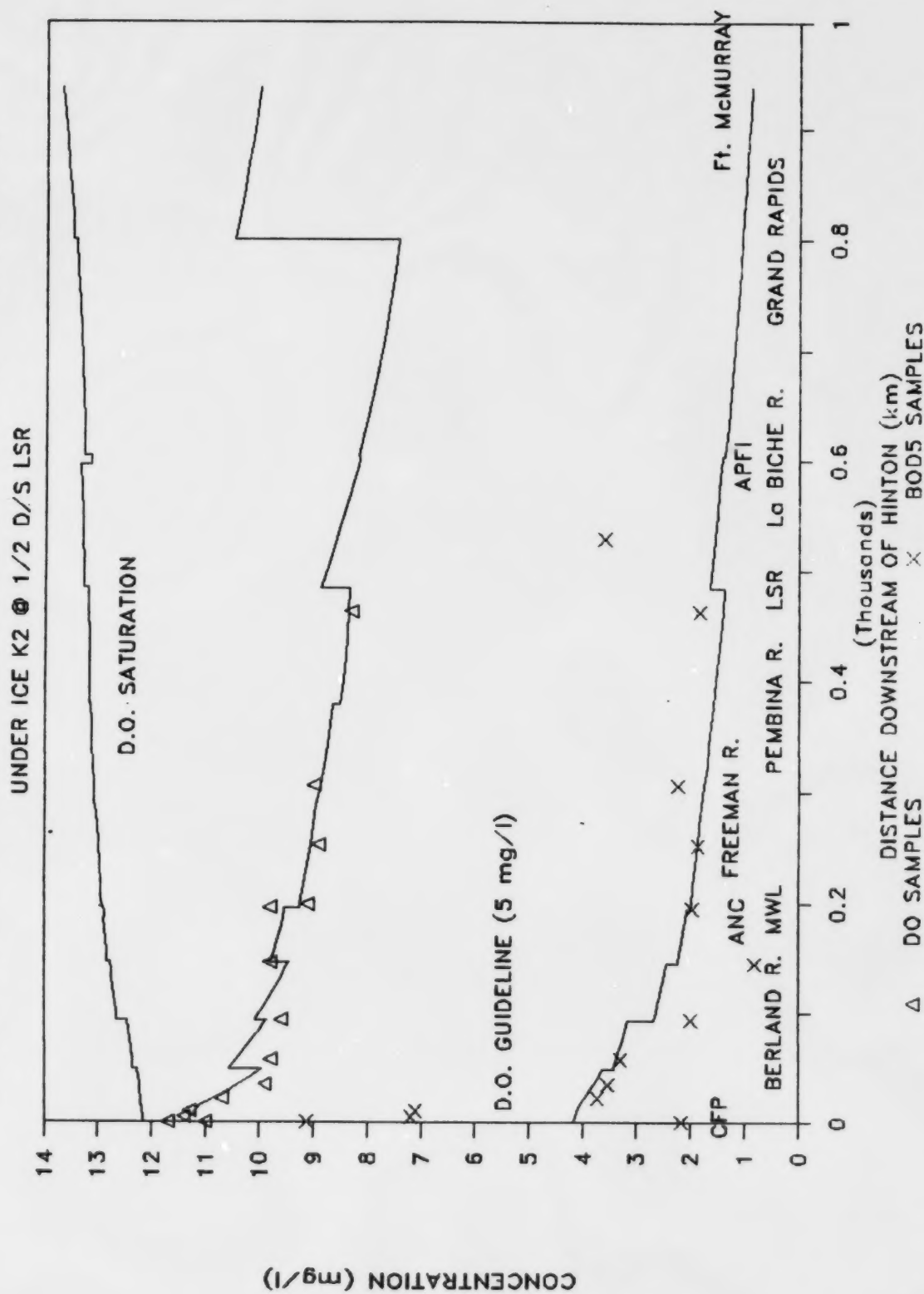
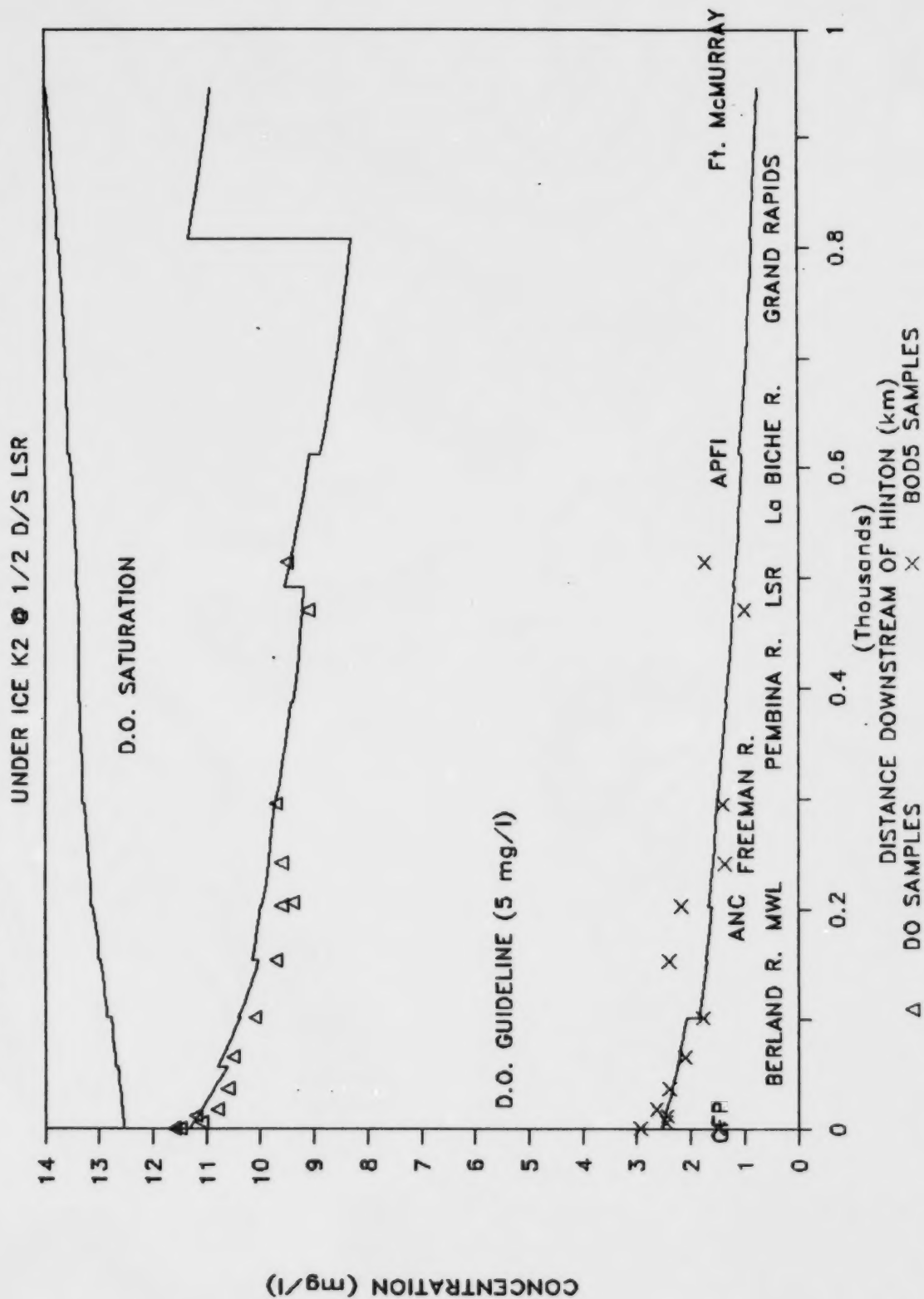


FIGURE 2.7 - SENSITIVITY RUN - MAR/88



Figures 2.8 (Run 1A) and 2.9 (Run 2A) show Runs 1 and 2 recalculated using reduced reaeration ($K_2 @ 1/2$) downstream of LSR. The results show that the dissolved oxygen profile downstream of APFI falls 1.7 mg/L lower (from 5.5 mg/L to 3.8 mg/L) for Run 1, and 1.5 mg/L lower (from 6.0 mg/L to 4.5 mg/L) for Run 2, with the reduction in reaeration. This suggests that the river dissolved oxygen profile is extremely sensitive to reaeration, and that a more extensive data collection program is necessary to have more confidence in the model results.

2.2.2.4 Downstream Mixing

The proposed APFI outfall would be located on the Athabasca River about 56 km downstream of the Town of Athabasca (about 8 km upstream of the La Biche River confluence). The outfall structure would be designed to discharge the effluent over 30% to 40% of the river width (in terms of flow) during the 7Q10 flow condition. The Athabasca River downstream of the APFI outfall has the following characteristics during the 7Q10:

7Q10 Flow (Q):	53.4 m ³ /s
Velocity (V):	0.29 m/s
Width (B):	260 m
Depth (H):	0.71 m
Slope (S):	0.00024
Shear Velocity (V*):	0.029 m/s
Shape Velocity Factor (SVF):	3.64 (ice-cover)
Dimensionless Dispersion Coefficient (K_z):	0.28

The shape velocity factor and dimensionless dispersion coefficient were taken from field dispersion studies by Beltaos (1978) on the Athabasca River at Athabasca.

FIGURE 2.8 - RUN 1A - K2 @ 1/2 D/S LSR

CFP @ 7;MWL @ 7.5;ANC,LSL @ 3;APFI @ 5

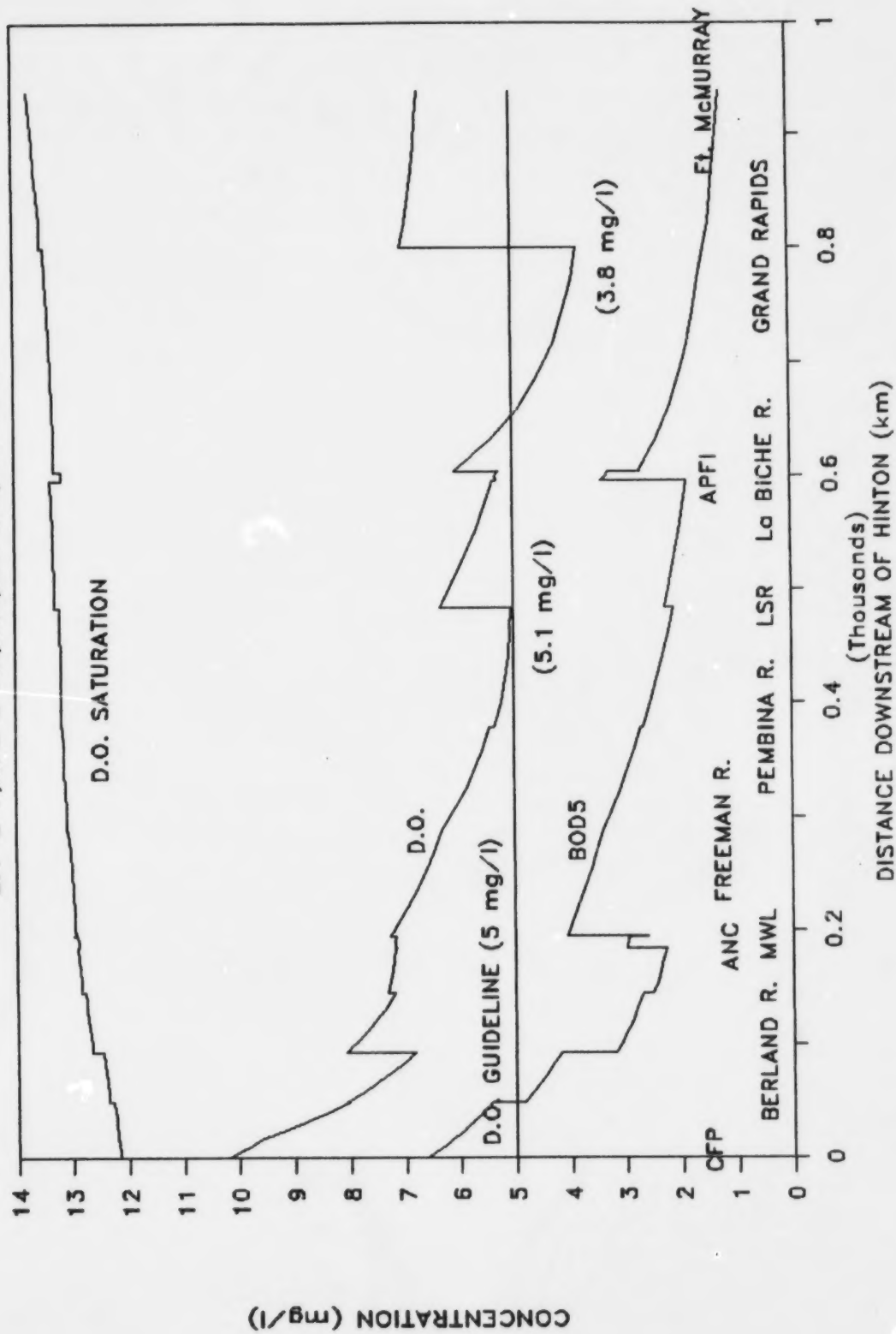
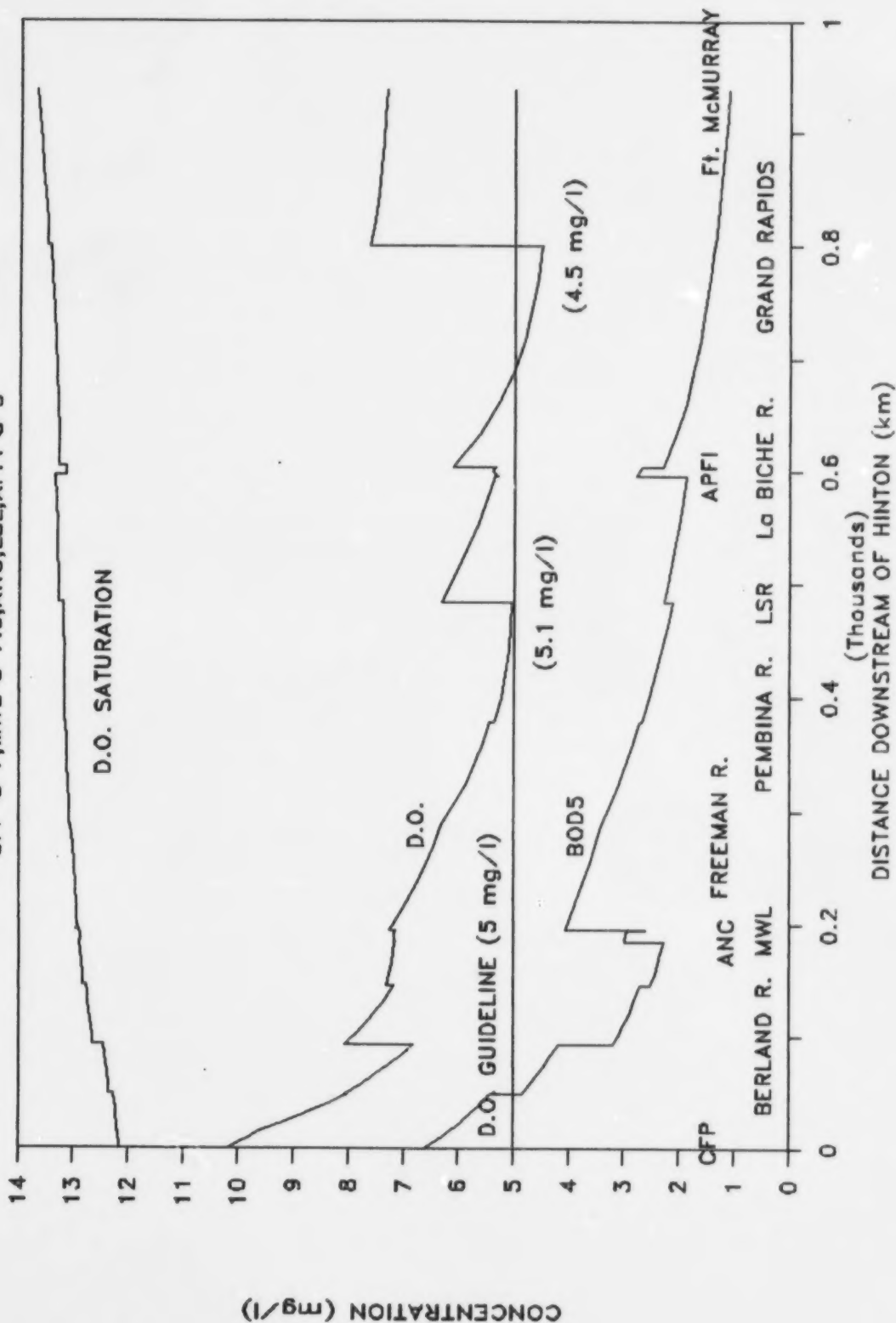


FIGURE 2.9 - RUN 2A - K2 @ 1/2 D/S LSR

CFP @ 7;MWL @ 7.5;ANC,LSL,APFI @ 3



The vertical mixing length can be estimated by equations presented by Fischer et al. (1979). From an application of his work to the outfall site the vertical mixing coefficient is in the order of $0.0014 \text{ m}^2/\text{s}$. This results in a vertical mixing length of about 50 m. At this point the effluent is fully mixed in the vertical dimension but has not spread significantly in the lateral direction. For the maximum effluent discharge rate into the river at the 7Q10 flow, the degree of dilution at this point would be about 20 to 1.

After the effluent mixes vertically, it is further dispersed as the river turbulence mixes it laterally. Transverse mixing and the mixing length for a river are controlled by the hydraulic conditions and the transverse mixing coefficient. Means to estimate the transverse mixing coefficient have been identified by Fischer et al. (1979) and Beltraos (1978). For an analytical dispersion model the dispersion coefficient (E_z) is given by:

$$E_z = (SVF)K_z(H)V^*$$

This results in a dispersion coefficient of $0.021 \text{ m}^2/\text{s}$. The mixing length (X_m) for a diffuser which extends almost to mid-stream is given by the equation (Hodgson 1986):

$$X_m = \frac{0.35 B^2 V}{E_z}$$

This results in a mixing length of 347 km for the APFI discharge to the Athabasca River at the 7Q10 flow.

Although complete mixing will, theoretically, occur at some distance downstream of the APFI outfall, it should be noted that:

- a) significant mixing due to the initial dilution of the diffuser outfall results in 20 to 1 mixing within 50 m of the outfall, and
- b) the presence of the Grand Rapids, about 200 km downstream of the proposed APFI outfall, limits the extent of the mixing zone (the rapids will ensure complete mixing).

Mixing in the Athabasca River was modelled using a two dimensional dispersion model (Figure 2.10) and an arbitrary effluent parameter concentration of 1,000 mg/L. It can be seen that the effluent does dilute rapidly and then declines gradually along the right bank until complete mixing occurs at the Grand Rapids. Concentrations along the left bank increase gradually indicating that a "zone of passage" will exist to allow fish migration along the stream in water that is essentially unaffected by the effluent.

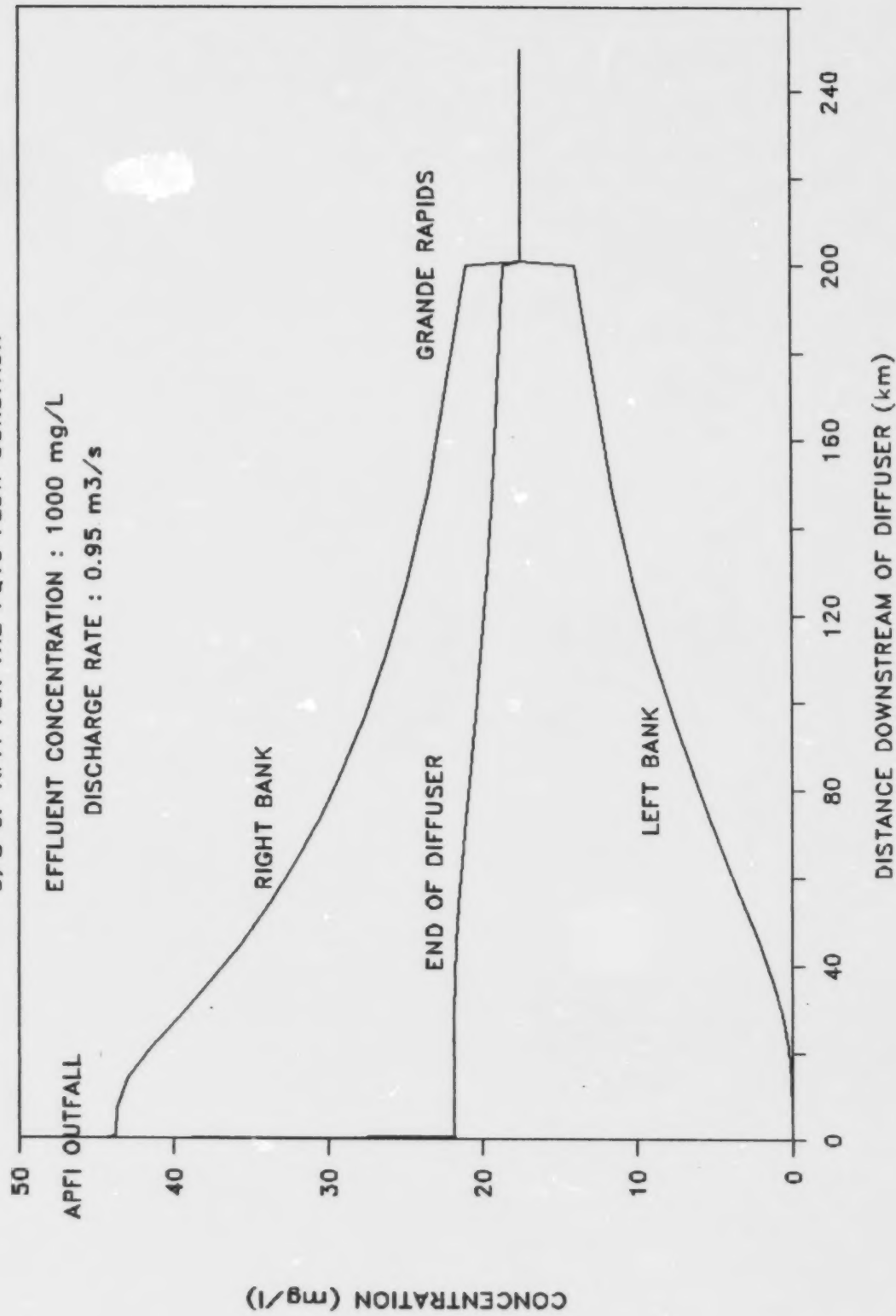
2.2.2.5 1989 Winter Field Program

In February 1989, a winter field data collection program was conducted in which hydrometric, dissolved oxygen, and biochemical oxygen demand conditions were determined at 23 sites over an 850 km stretch of the Athabasca River. The results of the field program and laboratory analyses were incorporated into the dissolved oxygen analysis model (D02) in order to validate the model parameters determined on the basis of the 1988 data.

The results of this analysis suggested that the model parameters are slightly conservative. However, there was not a sufficient discrepancy to suggest that refinements to the original model parameters are necessary. As a result, the work reconfirms that the original parameters selected were conservative and reasonable for assessing the impact of the mills located within the Athabasca River basin. The analysis of the anticipated loadings from all five mills during the design low flow condition (7Q10) indicates that the impact of all the mills does not endanger the dissolved oxygen guideline of 5.0 mg/L.

FIGURE 2.10 - MIXING IN ATHABASCA RIVER

D/S OF APFI FOR THE 7Q10 FLOW CONDITION





2.2.3 Suspended Solids

The APFI mill is designed to limit total suspended solids (TSS) discharges to 7.0 kg/t of pulp production, which corresponds to an effluent concentration of about 120 mg/L at the design flow of 0.95 m³/s. Dilution will reduce this concentration to 6 mg/L within 50 m of the diffuser at the 7Q10 flow. The increases in river TSS concentrations that would occur after final dilution at the minimum, 7Q10 and 7Q2 flows are shown in Table 2.16, while increases in TSS concentration on a mean monthly basis are shown in Table 2.17.

Table 2.16 Increases in Athabasca River TSS concentrations at low flows.

Low Flow	TSS increase at Fort McMurray (mg/L)
Minimum	1.7
7Q10	1.5
7Q2	1.2

Table 2.17 Mean monthly TSS concentrations (mg/L) in the Athabasca River after final dilution (as calculated at Fort McMurray).

Month	River Background	APFI Contribution
January	1.6	0.9
February	2.9	1.0
March	2.1	1.0
April	114.0	0.30
May	70.5	0.14
June	198.0	0.10
July	247.0	0.09
August	64.4	0.15
September	40.7	0.18
October	7.9	0.25
November	10.5	0.46
December	3.6	0.82
Annual	63.6	0.22

The Canadian water quality objective for TSS is 10 mg/L above background when background concentrations are below 100 mg/L (CCREM 1987). The APFI effluent would easily meet this requirement within 50 m of the diffuser even under the most extreme low flow conditions. APFI contributions of TSS to the river under normal flow conditions are insignificant compared to background concentrations except for the period December through March. On a yearly basis, they amount to less than 0.3% of mean background concentrations (Table 2.17). These very low additions of suspended solids to the Athabasca River are not expected to materially affect water quality or aquatic life, particularly in view of the high proportion of non-settleable solids in the total suspended solids component of kraft mill effluents.

2.2.4 Colour

Effluent emissions from the mill are expected to average 750 colour units at the design flow of 0.95 m³/s. This concentration will be reduced by dilution to less than 40 units within 50 m of the diffuser outfall. Increases in river colour following final dilution of the APFI effluent are shown for various flows in Table 2.18.

Table 2.18 Increases in Athabasca River colour after final dilution.

Flow	River Discharge (m ³ /s)	Colour increase (units)	
		at complete mixing	at Fort McMurray
7Q10	53.4	13	10
7Q2	75.8	9.3	7.4
February mean	90.0	7.8	6.0
May mean	688	1.0	0.8
July mean	995	0.7	0.5
September mean	487	1.5	1.1
Annual average	436	1.6	1.3

Background colour values in the Athabasca River are highly variable. Data presented by Hamilton et al. (1985) indicate that apparent colour (the colour imparted by both dissolved and suspended substances) in the Athabasca River averages about 20 units and reaches a maximum of approximately 160 units under ice cover, while during the open water period, typical and maximum values are in the order of 60 and 200 units, respectively.

The potential effects of added colour on the Athabasca River appear to be aesthetic only (CCREM 1987). The dilution factor is low enough in winter that some change in colour may be detectable in the open water area downstream of the outfall. During the open water season, colour discharges will be well within the normal variability of the river and should not be detectable except during low, clear flow periods and within a limited distance of the outfall.

The colour impacts of the mill on the Athabasca River will be minimized by the incorporation in the mill process of oxygen delignification, high chlorine dioxide substitution, and biological effluent treatment.

2.2.5 Chlorinated Organic Compounds

Kraft mill effluent contains a variety of chlorinated organic compounds produced during the bleaching process. According to Kringstad (1988), approximately 25% of these are in the low molecular weight (less than 1000) fraction. About 50% of this fraction consists of some 300 identified compounds, including chlorinated phenols, catechols, guaicol, resin and fatty acids, volatiles, and some aliphatics. The remaining 50% of the low molecular weight fraction consists of unidentified compounds. Some progress has been made in identifying the high molecular weight compounds such as the chlorinated lignins. These are generally heterogeneous compounds built up of simpler compounds found in the low molecular weight fraction. In all, approximately 80% of all the organically bound chlorine can be accounted for by identified low molecular weight compounds and "decently characterized" high molecular weight compounds. The unidentified 20% is thought to consist primarily of polymeric compounds in the range of molecular weights between 200 and 1000 (Kringstad 1988).

2.2.5.1 Bioaccumulation

The persistence of chlorinated organic compounds in the environment does not necessarily mean that they constitute a hazard to the environment. According to a comprehensive review of current knowledge about chlorinated organics in pulp mill effluents by Bonsor et al. (1988), the lower weight compounds such as the chlorinated phenolics are moderately bioaccumulative in fish but are readily excreted when the affected fish move to clean water. Some are quite toxic but they are only moderately persistent in the environment, with half lives of from a week to a few weeks. The higher molecular weight chlorinated organics are much more persistent in the environment but are not very toxic. These heavier compounds can, however, slowly decompose into lower molecular weight, more active compounds.

A study by the Alberta Environmental Centre (1987) showed that only 5 of the 61 compounds identified in a biologically treated kraft mill effluent were detected in downstream water, 3 in trace concentrations and 2 at 0.5 parts per billion or less. Moreover, the study revealed that only 3 of these 61 compounds had half lives of greater than 10 days in natural waters. Bioaccumulation of such chlorinated organic compounds, if it occurs, is usually in the livers of fish, not the muscle tissue. Thus the likelihood that these compounds will be ingested by people through fish consumption is slight (Voss 1987).

2.2.5.2 Toxicity

Most of the toxicity in pulp mill effluent is attributed to the chlorinated organic compounds: chlorinated resin and fatty acids, chlorinated phenols and, to a lesser extent, a broad group of neutral compounds such as chloroform and chlorinated sulphones. Bioassays and field tests have generated a variety of results on the sublethal effects of the organochlorine content of kraft mill effluent on aquatic organisms.

In general, biological treatment appears to significantly reduce acute toxicity of kraft mill effluents to fish and other organisms.

A detailed review by McLeay (1987) has shown that changes in distribution and abundance, histology, physiology, behaviour, growth and reproduction of fish in waters receiving biologically treated kraft mill effluents are minimal. Similarly, a study of a benthic macroinvertebrate community subjected to bleached kraft mill effluents demonstrated no change in species diversity and abundance during a 16-year period following mill start-up (Zanella and Weber 1981). Biomonitoring programs at both Weldwood (Hinton, Alberta) and at Procter and Gamble (Grand Prairie, Alberta) have shown similar results.

Recent Swedish research into the effects of bleached kraft effluents on fish in the Baltic Sea, however, provided a contradictory picture with the observation of various physiological effects such as liver enlargement, alteration of carbohydrate metabolism, decreased blood cell counts, reduction in gonad growth, change in enzyme activity and spinal column deformities (Bengtsson 1988; Larsson et al. 1988; Sandstrom et al. 1988; Tana 1988).

Bonsor et al. (1988) cautioned against the direct extrapolation of the Swedish findings to Canada. The harmful concentrations measured in the Swedish studies was extremely low, much lower than the no effect concentrations found in laboratory and ecosystem experiments undertaken in North America. It has been suggested (Sprague, pers. comm.) that other toxicants in the very polluted Baltic Sea are acting synergistically with those from pulp mill effluents to produce the observed sublethal effects. The Swedish results do, however, confirm the need for all bleached kraft mills to continue to strive to minimize chlorine usage wherever possible.

2.2.5.3 Impact Assessment

In Canada, chlorinated organic compounds are normally measured as total organic chlorine (TOCl), which gives the weight of organically bound chlorine; however, the AOX (adsorbable organic halides measurement, which is widely used in Scandinavia, is being adopted by Alberta Environment. AOX measures more organically bound chlorine than TOCl, for example, volatile compounds such as

chloroform and some chlorinated aliphatic compounds. The ratio of AOX to TOCl is variable but tends to be about 1.3. The TOCl measurement is used in this report, since much of the available biological research uses this measurement.

The effluent from the Alberta-Pacific mill is expected to average 1 kg TOCl per tonne of pulp produced. This can be derived from the material balance sheets (Figures 2.5 and 2.7, Section 2.4.3) and design criteria as established by Simons (1988a). About 90% of the elemental chlorine applied in bleaching remains as inorganic chloride and is discharged with the effluent (about 69.5% with the C-stage effluent, 10% with the E-stage effluent and 10% with effluent from the remaining stages). The pulp contains about 0.5% of the inorganic chloride. The remaining 10% of the chlorine applied ends up as TOCl. About 55% of the TOCl comes out with the chlorination stage filtrate, about 35% with the first extraction stage filtrate and about 10% in filtrate from the last three bleaching stages.

The low TOCl in the effluent of the proposed mill compares very favourably with existing kraft mills, which typically have TOCl production rates of 1.5 to 11 kg/t. In order to reduce TOCl production to the current state-of-the-art level of 1 kg/t, it was necessary for Alberta-Pacific to incorporate oxygen delignification, a unique five-stage pre-bleach washing treatment, high chlorine dioxide substitution, a low chlorine ratio, and biological effluent treatment.

The concentration of TOCl in effluent from the Alberta-Pacific mill will average 17.5 mg/L, and will be reduced to less than 1 mg/L within 50 m of the diffuser. Significant further dilution and decay of the chlorinated organics is expected as the effluent travels downstream. As noted earlier, biological treatment significantly reduces pulpmill effluent toxicity, apparently by removal of the lower weight organics (Kringstad et al. 1984; Beak 1987; McLeay 1987). Therefore, it is reasonable to assume that the treated effluent will contain proportionately low levels of the more toxic organics including chlorophenols and chlorinated resin and fatty acids.

With the exception of the Swedish studies, no data were found which indicated that these levels of TOCl represent a risk to aquatic organisms. Since the

Alberta-Pacific effluent will receive a level of treatment very uncommon in European countries, it is expected that the effluent toxicity will be as low or lower than that reported for other North American mills. Bioassay results for biologically treated pulp and paper mill effluents indicate no acute lethal toxicity to salmonid fish and other aquatic organisms even when tested at full strength and sublethal effects may occur only at high concentrations of 10% or more (McLeay 1987).

Considering the low level of discharge compared with other mills, and the high dilution factor available in the Athabasca River, emissions of chlorinated organic compounds from the Alberta-Pacific mill are not expected to have a significant effect on the river ecosystem and on the downstream water.

The effluent and Athabasca River water quality monitoring programs will include TOC1.

2.2.6 Dioxins

It has recently been discovered that extremely low concentrations of chlorinated dioxin and furan compounds occur in kraft mill sludges and wastewaters. These findings are the result of recent advances in analytical techniques rather than increases in the concentrations of these compounds due to changes in pulp mill technology. The presence of certain dioxins and furans is of concern because of their very high toxicity and their potential for inducing cancer. The best known of these compounds is 2,3,7,8,-tetrachlorodibenzodioxin, or 2378-TCDD, often referred to simply as "dioxin". 2378-TCDD and the closely related 2,3,7,8-tetrachlorodibenzofuran (2378-TCDF) are the most common of the dioxins and furans found in bleached kraft mill effluent (Kringstad 1988). 2378-TCDD is the most toxic known chlorinated organic compound, and 2378-TCDF is generally considered to be about one tenth as toxic (NCASI 1987, Bonsor et al. 1988).

Recent research indicates that chlorinated dioxins are formed in the chlorination stage of the bleach plant and, having low aqueous solubility, are associated with

fibres and other solid material. Chlorinated dioxin formation also appears to be related to contaminants in certain chemicals used in defoaming. There are certain oil-based defoamers containing precursor compounds which, when carried along with brownstock pulp into the bleach plant, can generate chlorinated dioxins and furans (Voss et al. 1988). Oxygen delignification and other methods of reducing TOC1 are known to concurrently reduce dioxin production (Bonsor et al. 1988).

2.2.6.1 Environmental Pathways

One of the important issues concerning dioxin and furan compounds is their persistence in the environment. In addition to the recent discovery of very low levels of such substances in kraft mill effluents and sludge, these compounds are apparently created by incineration of municipal waste contaminated with chlorinated compounds and combustion of leaded gasoline in automobiles (NCASI 1987). Thus, the existence of dioxin and furan, and their bioaccumulation in various organisms, including humans, through various pathways have been the subjects of extensive studies. For bleached kraft mill processes, the possible sources of dioxin and furan would be from effluent discharge, air emissions and sludge disposal.

Any dioxin and furan compounds produced in bleached kraft mill effluent are readily adsorbed into the suspended solids of the treated effluent owing to their relative insolubility in water and strong binding to organic material (Bonsor et al. 1988). In the aquatic environment, various processes, such as microbiological decomposition, metabolism within aquatic organisms and direct chemical breakdown via photolysis and volatilization, can lead to the eventual destruction of these compounds (MOE 1985) but rates are extremely variable. The half life for volatilization of 2378-TCDD in sediments is estimated to be 5.5 and 12 years from a pond and a lake respectively, but that for photolysis is measured in terms of hours (MOE 1985).

In the aquatic environment, organisms can accumulate dioxin and furan compounds in their body tissues. It has been reported that the bioconcentration factor of 2378-TCDD in rainbow trout can be up to 9,270 (Branson et al. 1985).

In addition to aquatic pathways, dioxins and furans may occur in both some sludges and could potentially be emitted through incineration of chlorine contaminated materials in the power boiler. For the sake of completeness, these issues have been addressed here. Any dioxins and furans emitted through the power boiler stack would be transported into the atmosphere. The relatively rapid degradation of these compounds by ultra-violet light is well documented (Choudhry and Hutziager 1982). Any deposition of dioxin contaminated dust on the soil surface could however also be readily absorbed by organic matter (Palausky et al. 1986), resulting in limited mobility in the soil profile (Walters et al. 1986).

There are contradictory studies reported on dioxin uptake in plants. Sacchi et al. (1986) showed that maize and bean plants grown on soil contaminated with 2378-TCDD absorbed significant amounts of TCDD and accumulated it in the aerial parts through the transpiration process. In contrast, experiments by Fachetti et al. (1986) did not show a significant increase of dioxin uptake in the aerial parts of maize and bean plants but suggested that the root and aerial parts were mainly contaminated by direct contact and evaporation from the soil. A review by Kenaga and Norris (1983) concluded that plants do not bioconcentrate dioxin from the soil because of their low fat content. Therefore, it appears highly unlikely that crops would incorporate significant amounts of 2378-TCDD (NCASI 1987).

Grazing animals which ingest dirt along with their food could take up dioxin from soil. Meat and milk in some farm animals have been shown to contain detectable amounts of dioxin in the low ppt (parts per trillion) range. However, animals grazing on well-grassed fields and feeding on grain and harvested grasses at feed lots apparently ingest little or no dioxin (NCASI 1987). There are few data on the possible biomagnification of dioxin in the food chain (MOE 1985).

As dioxin and furan compounds are strongly adsorbed onto organic matter, their mobility in sludge would be very limited. Thus, these compounds, if present, can be expected to stay with the particulate matter of the sludge in the landfill site (Bonsor et al. 1988).

2.2.6.2 Toxicity

Waterborne 2378-TCDD and 2378-TCDF are toxic to fish, with the chlorinated furan being an order of magnitude less toxic. Sublethal effects of these compounds include retardation of growth, particularly in fish larvae (Bonsor et al. 1988). Mehrle et al. (1988) found toxicity at extremely low concentrations in laboratory experiments with rainbow trout: they reported a 56 day LC₅₀ of 0.046 ppt and growth impairment at 0.038 ppt. However, the same researchers also indicated that the dioxin and furan residues recently found in wild fish may not, by themselves, be directly harmful to fish, as there is no proven correlation between such residues in the body and a deleterious effect. There is also no firm evidence to confirm that any of the dioxin and furan compounds are toxic to natural vegetation and field crops, or that they have had any long-term toxic effects for animals living their entire life cycles in areas where the soil has been contaminated with dioxin (MOE 1985).

The most serious concern regarding dioxin is its potential carcinogenicity, as evidenced in rats and mice (NCASI 1987). Attempts to correlate effects of dioxin in animals to humans are, however, restricted by the limited knowledge about levels of human exposure of dioxin in the environment. The information that is currently available suggests that humans may be less sensitive to dioxin's toxic effects (NCASI 1987). Clearly, further studies are needed to ascertain if a cause-effect relationship exists in humans, and certainly every effort should be made to control dioxin emissions.

2.2.6.3 Impact Assessment

Levels of dioxin in kraft mill effluents vary significantly. One source of difference is analytical imprecision since the levels are often close to the current

detection limits of approximately 0.01 parts per trillion (10 parts per quadrillion). However, it is clear that dioxin levels, like those of other chlorinated organics, can be significantly reduced by reducing the use of elemental chlorine in the bleaching process. It is now considered possible to reduce dioxin levels to below detectable levels in pulp mill effluents.

The following technologies have been implemented in the design of the Alberta-Pacific mill in order to decrease the amount of dioxin released to non-detectable levels:

- o extensive brownstock washing to minimize carryover;
- o oxygen delignification;
- o a highly efficient post-oxygen delignification washing system;
- o medium density chlorination;
- o high (70%) chlorine dioxide substitution;
- o low chlorine - kappa ratio;
- o multiple chemical addition system in the first bleaching stage;
- o the use of defoamers that are free from dioxin precursors; and
- o steam stripping of contaminated condensate that is to be reused in the process.

The major environmental concern with respect to dioxins in pulp mill effluent is the possibility of their accumulation in fish and subsequent consumption by humans. A recent survey by the Federal Government (Ottawa, news release, 16 May 1988) of 75 fish samples collected at the vicinity of pulp and paper mills in the provinces of British Columbia, Alberta, Saskatchewan and New Brunswick showed either no residues of 2378-TCDD (in 34 samples) or levels well below the 20 ppt tolerance limit (in 41 samples) set by the Canadian Health and Welfare Guideline. Considering that the Alberta-Pacific pulp mill has been designed to reduce chlorine discharge to the minimum level currently achievable, there is no reason to expect that uptake of dioxin in fish will become an environmental issue.

A secondary concern with respect to 2378-TCDD is potential direct toxicity to fish. The concentrations reported by Mehrle et al. (1988) are well above the expected dioxin concentration of less than 0.01 ppt in Alberta-Pacific effluent. Further, it should be noted that the laboratory toxicity results occurred during long-term (about 2-month) exposures to 2378-TCDD, whereas fish in the Athabasca River would be free to move away from toxicants (see Section 2.2.2.5). Dilution will further reduce dioxin concentrations by a factor of 20 within 50 m of the diffuser outfall to nearly two orders of magnitude below the potentially toxic concentrations reported by Mehrle et al. (1988). In this context, it appears extremely unlikely that fish in the Athabasca River could suffer any toxic effects as a result of dioxin emissions from the proposed mill.

Although not directly related to water quality, the issues of chlorinated dioxins in stack emissions from the power boiler and sludge from the effluent treatment system are of concern. In the proposed Alberta-Pacific mill, all the sludge produced from the primary clarifier will be incinerated with the wood yard waste. The possible concern over the presence of chlorinated dioxins in bleached kraft mill air emission is new to the pulp and paper industry and a final conclusion regarding their potential to affect environmental and human health has not yet been reached by government agencies. It is expected that the Canadian Pulp and Paper industry's national bleached pulp mill dioxin survey program and the Paprican (Pulp and Paper Research Institute of Canada) program on dioxin reduction and alternate bleaching systems will help gauge the extent of the problem and provide further means of reducing or eliminating the presence of such compounds through process modifications.

It should be noted that the design operating temperature of the power boiler (1470°C) should be high enough to ensure complete destruction of dioxin and furan compounds.

In view of public concerns about dioxin releases to the environment, Alberta-Pacific will cooperate with Alberta Environment in implementing a comprehensive monitoring program to be continued long enough to ensure that harmful quantities of dioxin do not enter or accumulate in the Athabasca River as

a result of Alberta-Pacific's operations. No data are currently available on baseline dioxin concentrations in Athabasca River water or fish in the vicinity of the mill site. The program is therefore anticipated to include:

- measurement of baseline dioxin concentrations in an edible fish species (e.g. walleye) in the vicinity of the mill;
- monitoring of dioxin concentrations in edible fish in the vicinity of the mill; and
- monitoring of dioxin concentrations in mill effluent.

2.2.7 Bacteria

Pulp mill effluents commonly contain bacteria of the genus Klebsiella, usually Klebsiella pneumoniae. Public health officials have expressed concern over the presence of Klebsiella bacteria, presumably because K. pneumoniae shows a positive response in both the standard total and fecal coliform tests, and because under certain circumstances it is pathogenic (i.e. capable of causing disease). No data linking waterborne Klebsiella and human disease have ever been presented, however, and a recent study of the health significance of Klebsiella in the environment (Duncan 1988) concluded that the presence of Klebsiella in lakes and streams does not appear to produce human disease, either in the community or hospital environments.

Site sewage (including construction camp sewage) will be treated before entering the effluent treatment system at the secondary settling pond and then being processed through the aerated basins. Findings by Bell et al. (1979) for untreated sewage placed in a kraft pulp aerobic treatment system indicated that Salmonella sp. did not appear to survive the treatment system at all, and that removal of total coliforms and fecal coliforms was 99.87% and 99.6% respectively. Overall coliform removal efficiencies are predicted to be higher for the Alberta-Pacific system because of the double treatment of sewage, and no downstream coliform - related impacts are expected.

2.2.8 Off-Flavours in Fish

In a detailed review of tainting associated with pulp and paper effluents, McLeay (1987) reported that untreated bleached kraft mill effluents do impart off-flavours to fish under continuous exposure in laboratory conditions. The effluent constituents responsible remain unknown, although 2,4-dichlorophenol, 2,4,6-trichlorophenol and possibly other chlorinated organic compounds appear to be likely candidates. McLeay (1987) also reported the results of four studies that attempted to confirm fish off-flavours resulting from treated bleached kraft mill effluent discharges in the receiving environment (i.e. the river). He found that although some qualitative evidence of off-flavour was reported, in none of the studies was the evidence for tainting conclusive, and in no case could the pulp and paper mill be clearly identified as the only potential tainting source. Similarly, there have been anecdotal reports of fish tainting below the Champion mill on the Athabasca River at Hinton, but no actual evidence of tainting has ever been found (Stanley 1987).

The low concentration of chlorinated organics that will be achieved in the APFI effluent (section 2.2.5) and the large dilution capability of the Athabasca River suggest in the context of the information reported by McLeay (1987) that the operation of the mill is unlikely to cause changes in the flavour of fish.

2.2.9 Nutrients

Kraft mill effluents contain both nitrogen and phosphorus. Of these, phosphorus is of more potential concern because it is generally the nutrient limiting primary productivity in fresh water systems. In oligotrophic streams such as the Athabasca River, small increases in phosphorus can be beneficial, resulting in increases in benthic invertebrate and fish production. Large increases can result in excessive enrichment, however.

It is currently impossible to quantify the potential impact of phosphorus additions to the Athabasca River from the APFI effluent. Impacts of phosphorus enrichment (increased growth of algae and benthic invertebrates) will be readily

detected in the benthic monitoring program (section 3.2). If detected, APFI will undertake to reduce levels of phosphorus addition or if this is not feasible, to remove phosphorus using either physical-chemical means (e.g. alum) or biological methods.

2.2.10 Metals

In a major review of effluents from Canadian pulp and paper mills (McLeay 1987), metals were not discussed, strongly suggesting that they are not a significant environmental issue in pulp mill effluents. With time, some metals may enter process or cooling water due to corrosion, but this source should be very small. Metal toxicity, if any does occur, would be detected in the routine bioassay (section 3.2).

2.2.11 Sulphates

Sulphate concentrations in the APFI effluent are predicted to be about 7 mg/L. Dilution will reduce this figure to well under 1 mg/L within 50 m of the effluent diffuser. By comparison with background concentrations of sulphates in the Athabasca River (Table 2.1), mill emissions are small.

2.2.12 Odour

The biological treatment of effluent greatly reduces odour due to volatilization of odorous compounds during aeration. The natural processes of dilution, absorption, volatilization and decomposition further reduce odours in discharged effluent until they cannot be distinguished from those contributing to natural odour in the river downstream of the mill. The Alberta-Pacific effluent is not expected to cause off-odours in drinking water for downstream users; however, it may cause some odours in the immediate vicinity of the outfall.

Effluent-related odours from the Alberta-Pacific mill will be minimized by the long retention time of the effluent treatment system and the rapid dilution that will be provided by the diffuser outfall.

2.2.13 Phenols

The phenolic compounds of principal concern in bleached kraft mill effluents are the chlorophenols. These have been discussed in Section 2.2.5.

2.2.14 Sodium and Chloride

The concentrations of sodium and chloride in mill effluent are predicted to be about 20 mg/L and 10 mg/L, respectively. Dilution will reduce these concentrations to 1 mg/L and 0.5 mg/L, respectively, within 50 m of the effluent diffuser. These levels of inputs are small compared to background concentrations (Table 2.1).

2.2.15 Ammonia

Ammonia is used sparingly in the effluent treatment ponds, where it is converted to nitrate/nitrite and provides the nitrogen required for bacterial decomposition. Ammonia concentrations in the effluent are expected to be extremely low, well below potentially harmful levels.

2.2.16 Water Temperature

Because the effluent temperatures will be relatively cool (less than 25°C), and because the effluent volume will be small compared to Athabasca River flows at all times, Athabasca River water temperatures will not be adversely affected by mill operations. An ice-free zone approximately 4 km long is expected to occur in winter downstream of the effluent diffuser.

2.2.17 Local Watercourses

During mill construction, water quality in local streams will be protected by leaving a 50 m undisturbed buffer zone along all watercourses. If necessary, additional runoff control and containment measures such as berms, drainage ditches, and settling ponds will be used. Fuel storage areas will be located far from watercourses and will be designed for total containment of spilled fuels.

During mill operation, surface runoff and snowmelt from the mill site will be collected by two independent drainage systems. Runoff from the wood handling areas will be routed to the effluent treatment system, while runoff from the remainder of the mill site will be routed to a storm drainage settling pond, from which it will discharge to the environment. Thus, site stormwater and snowmelt runoff will not adversely affect water quality in local streams.

Contamination of surface water in local streams as a result of spills is unlikely because of extensive in-plant and out-plant spill controls. Provision will be made for contaminated surface water and snowmelt to be channelled to the emergency spill pond via bypasses from the settling pond in the effluent treatment system and from the storm drainage settling pond.

Potential contamination from groundwater sources is unlikely, as discussed in Section 5.2.

Baseline data on seasonal flows and water quality in the two watercourses close to the mill will be obtained prior to mill construction. These data will be tied in to a surface water quality monitoring program to be maintained throughout the construction and operation periods. Additional monitoring will be carried out in the event of a spill incident.

2.2.18 Acidification

Streams will not be affected by the small increase in sulphur deposition caused by mill atmospheric emissions, as Alberta rivers in general are not susceptible to

acidification (Legge 1988). Lakes in the area are generally well buffered against acidification because of high pH, alkalinity and calcium values and are rated as having low susceptibility to acidification, except for a small area of low to medium susceptibility northeast of Lac La Biche (Erickson 1987, Palmer and Trew 1987). Thus, no project related acidification of lakes is anticipated.

3.0 FISHERIES

3.1 EXISTING FISHERIES RESOURCES

The portion of the Athabasca River adjacent to the proposed mill site lies within the Athabasca Mainstream Sub-Basin II as defined by Wallace and McCart (1984). This is the least understood area along the mainstream Athabasca and fish populations have been little studied.

The Athabasca River within Sub-Basin II is relatively shallow and is characterized by a high sediment load. Substrates are gravel mixed with local sands and clays. A habitat assessment conducted along the section of the river near the mill site during September 1988 indicated that this is a rather uniform reach, similar to the sections just upstream and downstream. It consists mainly of run habitat broken by a few sandbars and islands. A few backwash areas create some pool habitat, but no riffle habitat was evident at the time of the habitat assessment. The banks are fairly low, consisting mainly of steep, unstable mud slopes and secondarily of gravelbars.

Wallace and McCart (1984) provide no information on the species of fish that may be present within this section of the Athabasca River; however, fisheries investigations conducted during September 1988 by Beak Associates on the Athabasca River at Calling River revealed a species assemblage typical of the well-studied section of the mainstream downstream from Fort McMurray. Pike, walleye, goldeye, white suckers and longnose suckers were captured at Calling River, and these same species are very likely present in the vicinity of the proposed mill site, which is only 30 km upstream. Several cyprinid species common to the lower section of the Athabasca are also expected to occur here, and arctic grayling and lake whitefish may be present on a seasonal basis (Scott and Crossman 1975).

Generally, the Athabasca River in the vicinity of the proposed mill site appears to provide moderately good habitat for sportfish species. No critical habitat was identified during the habitat assessment, however, for any life stages of sportfish species.

No studies have been done on possible fish movements from the Athabasca River into Lac La Biche, although there have been reports of grayling in Lac La Biche that probably originated in the Athabasca River (Brown 1989). Downstream movement of pike and perch from Lac La Biche into the La Biche River has been documented, and it is possible that pike and walleye from the Athabasca River utilize spawning habitat in the La Biche River. It seems unlikely, however, that Lac La Biche walleye populations are resident in the Athabasca River.

3.2 Impacts on Fisheries Resources

The potential direct impacts of the pulp mill on fisheries are related to effluent release and include acute (lethal) toxicity, chronic (sublethal) toxicity, and "tainting" or production of off-flavours in fish flesh.

Acute toxicity in the river is extremely unlikely to occur, as the following safeguards have been incorporated into the project:

- In compliance with Alberta Environment requirements, the pulp mill effluent will be tested on a routine basis to ensure that it remains non-toxic.
- Site runoff will not enter the river directly, but will enter the effluent stream ahead of treatment.
- The diffuser discharge system will ensure 20:1 dilution of the effluent within 50 m of the outfall.
- In-plant spill controls and an out-plant emergency spill basin will prevent spilled chemicals from entering the river directly or upsetting the effluent treatment system.

Evidence regarding sublethal impacts on fish (e.g. morbidity, growth impairment) in waters receiving treated bleached kraft mill effluent is inconclusive. Chronic toxicity is, in fact, often difficult to detect in non-laboratory conditions unless the effects are obvious. The potential for sublethal toxic effects in the Athabasca River resulting from mill operation will be minimized by:

- process modifications to decrease the production of potentially toxic chlorinated organic compounds, which are not readily removed by effluent treatment,
- rapid dilution of effluent due to the diffuser type outfall configuration,
- the large dilution factor available even at low flows,
- the existence throughout the effluent mixing zone of effluent-free portions of river into which fish can move, and
- implementation of a benthic monitoring program to look for potential chronic toxicity problems.

The evidence for fish "tainting" (production of off-flavours in fish flesh) in waters receiving treated bleached kraft mill effluent is, like that for chronic toxicity, equivocal. Tainting is not directly harmful to fish and, as explained in Section 2.2.8, is not expected to occur as a result of mill effluent releases.

It is not known whether there will be a zone of fish avoidance downstream of the effluent outfall. If such a zone were to occur it would be very short due to the rapid mixing and dilution of effluent effected by the diffuser outfall structure. There is ample provision for fish passage outside any possible avoidance area, since 1) the outfall structure will extend less than one third of the way across the river and 2) complete bank-to-bank mixing of the effluent will not occur until Grand Rapids, some 200 km downstream, at which point the effluent will be extremely dilute.

The project is not expected to affect the Lac La Biche fishery.

Increased fishing pressure on nearby reaches of the Athabasca River may occur as an indirect result of the project. The potential for increased fishing pressure will be greatest during the construction period. No other significant indirect effects of the project on fisheries are foreseen.

4.0 DOWNSTREAM WATER USERS

The major water users on the Athabasca River downstream of the proposed mill are the City of Fort McMurray, Suncor Inc. and Syncrude Canada Ltd. (Alberta Environment 1985). Table 4.1 lists all of the active water users on the Athabasca River downstream of the mill site as far as Fort McMurray.

There is also at least one possible future water user on the Athabasca River, the OSLO Tar Sands project.

Table 4.1 Licensed water users on Athabasca River downstream of Athabasca.

Land Location	Applicant Name	Purpose	Annual Quantity (dam ³)
NW17-089-09-4	Fort McMurray, City	Municipal	17,100
SE20-089-09-4	Fort McMurray, Town	Municipal	1,100
SE20-089-0-4	Fort McMurray, Town	Municipal	6,400
SW32-089-09-4	Conmac Western Industries	Industrial	37
NE12-089-10-4	Fort McMurray Golf	Irrigation	-
SE25-092-10-4	Suncor	Industrial	59,800
NW35-092-10-4	Syncrude	Industrial	61,700

As indicated in Section 1.0, consumptive water use by the proposed mill will be too small to affect the availability of water to downstream users. Water quality changes (Section 2.2) are expected to be too small to materially affect downstream users, although changes in colour may be detectable during periods of low flow.

The health of downstream water users is not expected to be affected by the project (Appendix 7).

5.0 HYDROGEOLOGY

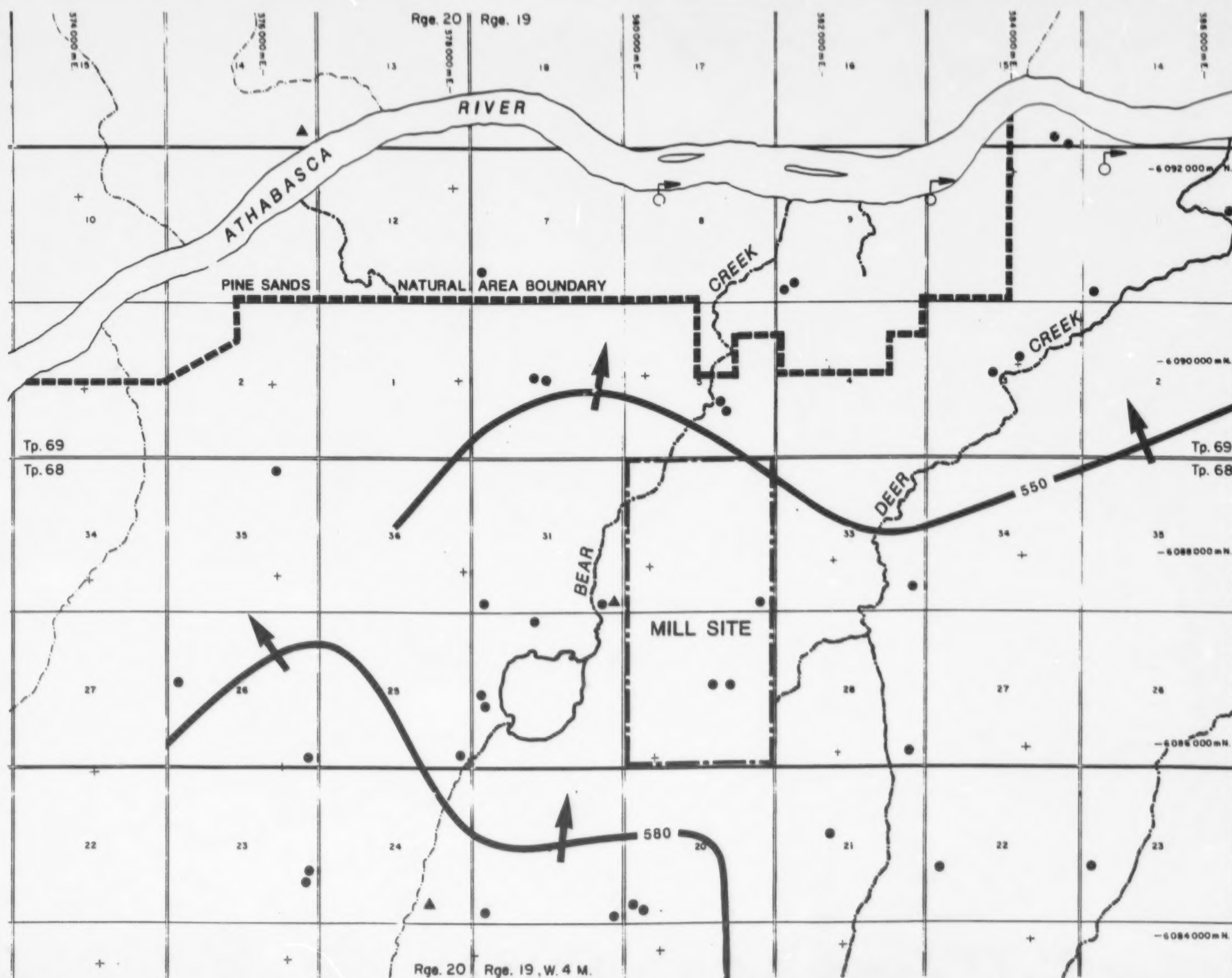
5.1 EXISTING ENVIRONMENT

Two hydrostratigraphic units underlie the project area (Borneuf 1972). The basal unit is the bedrock, the Lea Park Formation, a Cretaceous aquitard composed primarily of shale. Since it is a poor source of water, few of the existing wells in the area tap this unit. Overlying the bedrock is a Quaternary hydrostratigraphic unit consisting primarily of glacial till, sand and gravel. Most of the known wells (Figure 5.1) tap this surficial aquifer.

Data from local water well logs obtained from the Groundwater Resources Information Service have been examined in detail. The piezometric levels associated with the surficial aquifer are approximately 3 m to 5 m below ground surface. It is believed that groundwater from these glacial sand and gravel deposits discharges into watercourses in the vicinity of the mill site. These deposits are about 1 m thick and generally yield 2000 to 3000 litres per day. Figure 5.1 indicates that the hydraulic gradient of these deposits is about 1% through the mill site; assuming this is the case, a groundwater flow velocity of 0.2 m/day can be estimated from the well log data.

Test hole data from a geotechnical investigation carried out during 1988 (Appendices 3, 8) indicate that groundwater is perched in the surficial materials of the mill site at depths ranging from 2 to 10 m below the ground surface.

Surficial groundwater flow directions in the vicinity of the mill site are influenced mainly by the Athabasca River, and the horizontal component of groundwater flow is toward the river over the entire project area (Figure 5.1).



NORTH

LEGEND

- ▲ EXISTING WELLS (BEDROCK)
- EXISTING WELLS (SURFICIAL)
- 550— POTENTIOMETRIC SURFACE (METRES)
- ➔ DIRECTION OF SURFACE GROUNDWATER FLOW
- SPRINGS IN BEDROCK
- - - SURFACE DRAINAGE

SCALE

0 500 1000 2000m

Appendix 1

Figure 5.1

HYDROGEOLOGY



Available chemical analyses (Table 5.1) indicate that groundwater in the surficial aquifer is generally very hard, slightly alkaline, and high in dissolved iron. Calcium and magnesium are the dominant cations and bicarbonate is the dominant anion. The chloride content is variable, but generally low. Total dissolved solids concentrations are generally less than 1000 mg/L and thus are acceptable in terms of potability.

Table 5.1 Well water quality (mg/L)

Parameter	No. of Wells	Mean	Std.	Max. Dev.	Min
pH	41	8.3	2.7	25	6.9
Iron	54	1.0	1.3	5	0.02
Calcium	44	112.4	70.9	292	1
Hardness	53	456.1	261.0	1072	12
Potassium	39	6.2	10.2	58	1
NO ₂ and NO ₃	29	6.5	15.8	77.5	0.02
Fluoride	43	0.2	0.1	0.47	0.11
Sulfate	54	141.8	142.1	637	5
Alkalinity	50	408.1	121.4	615	17
Conductivity	40	1242.3	563.2	2890	409
TDS	54	733.0	352.5	1589	108
Magnesium	44	37.9	24.3	119	1
Sodium	39	95.0	109.1	445	6
Silica	30	15.2	3.3	21.3	10.2
Nitrite	28	0.2	0.3	1.58	0.005
Chloride	55	51.0	103.4	725	1
Bicarbonate	43	478.4	158.4	750	130

5.2 IMPACTS

In some area, mill site grading will necessitate the lowering of groundwater levels, likely by means of perimeter and cross-site ditches. Water collected in these ditches will be collected in a settling basin before discharge to local watercourses. Water quality in the settling basin will be periodically monitored.

The risk of groundwater contamination resulting from the mill operation is very low because:

- process water and chemicals will be totally contained,
- in-plant and out-plant spill controls will be provided,
- site hardening will minimize infiltration of surface runoff/snowmelt to the surficial aquifer,
- site runoff will be collected and directed either to the effluent treatment system or the storm drainage settling pond,
- the effluent treatment lagoons will be lined, and
- there will be no on-site disposal of liquid wastes.

It is possible that some reduction of groundwater levels will occur down-gradient of the mill due to the interception of groundwater flows and the collection of surface runoff water and snowmelt.

Surficial groundwater quality will be monitored in the vicinity of the mill site by means of a series of on-site and off-site wells, which will be installed early enough to establish baseline conditions. The wells will be situated both upgradient and downgradient to monitor the overall mill site and also specific areas such as the effluent treatment lagoons and the solid waste disposal sites. Groundwater levels in these wells will also be monitored. In the event that any groundwater changes are detected on site, immediate remedial action will be taken to prevent off-site groundwater users from being

affected. Alberta-Pacific will guarantee maintenance of water supplies for local well owners should any project-related effects on groundwater quality or quantity occur.

The groundwater flow pattern shown in Figure 5.1 indicates that the only existing wells within the potential sphere of influence of the mill are those to the north and the immediate west of the millsite.

6.0 SUMMARY OF AQUATIC MONITORING PROGRAMS

The aquatic monitoring programs planned by Alberta Pacific will be coordinated by a full-time biologist beginning two years prior to start-up. The programs include:

- o monthly water quality monitoring in the Athabasca River near the mill site of temperature, dissolved oxygen, pH, colour, total suspended solids, sodium, sulphate, chloride, ammonia nitrogen, nitrate and nitrite, total phosphorus and ortho-phosphorus during the construction period;
- o monthly water quality monitoring in the Athabasca River in the vicinity of and downstream of the effluent diffuser of the above parameters as well as biochemical oxygen demand, phenolics, coliform bacteria, zinc, manganese and total organic chlorine during mill operations;
- o regular effluent quality monitoring, including toxicity, TOC1 and dioxins;
- o a benthic monitoring program in the Athabasca River during mill construction and operation;
- o dioxin baseline studies and monitoring in edible Athabasca River fish in the vicinity of the mill site prior to mill start-up and during mill operation;
- o groundwater quality and quantity monitoring using a system of on-site and off-site monitoring wells; and
- o water quality and quantity baseline studies and monitoring in local watercourses (Bear Creek and Deer Creek) during mill construction and operation.

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1.0 INTRODUCTION

Alberta-Pacific Forest Industries Inc. (APFI) purposes to build a 1500 ADMT/day bleached kraft pulp mill at a site approximately 30 km northeast of Athabasca, Alberta. An evaluation of the existing air quality in the vicinity of the pulpmill and an assessment of the effects of emissions from the mill on air quality was carried out as part of the environmental impact assessment. This assessment included particular, gaseous and water vapour emissions and an evaluation of ambient odour and noise levels in the vicinity of the pulpmill.

The objectives of the air quality assessment were as follows:

- to review existing meteorology and climatological data,
- to assess the existing air quality,
- to predict ambient air concentration levels from expected emissions from the mill stacks using appropriate dispersion models, and
- to evaluate the impacts of the mill operation on the receiving environment.

The proposed plant site is surrounded by wooded, undulating terrain. The ground elevation in the area varies from approximately 530 m to 600 m; the elevation at the proposed plant location is 570 m, decreasing to 500 m close to the Athabasca River.



2.0 METEOROLOGICAL CONDITIONS

A review of the weather patterns for a particular region assists in predicting the behaviour of effluent plumes and in determining if plumes will be dispersed efficiently under turbulent, unstable atmospheric conditions or if they will be trapped close to the ground under stable inversion conditions.

Wind results from differences in atmospheric pressure and air temperature variations. Friction forces and the rotation of the earth also influence the wind. The pressure forces are caused directly by high (anticyclones) and low pressure regions (cyclones) in the atmosphere. In the Northern Hemisphere air blows in a clockwise direction around a region of high pressure. Temperature inversions frequently are caused by high pressure fronts moving into areas previously occupied by low pressure systems with warm air moving over cooler air and hindering vertical movement and mixing.

The change of temperature of the atmosphere with altitude (the lapse rate), also has a large influence on the dispersion of plumes. This temperature profile determines how much turbulence is available in the atmosphere for diffusion and dispersion.

In general, the climate of North-Central Alberta is characterized by long, cold winters and short cool summers. Precipitation is appreciable and there is considerable wind and air movement.

Long-term climatological data for the project area have been collected by Environment Canada. Air data from the weather station at Lac La Biche form the basis of this assessment. However, additional data from weather stations at Athabasca, Calling Lake and Wandering River have also been reviewed. The following data have been reviewed:

- temperature, pressure, relative humidity;
- precipitation, rain and snow;
- wind speed and direction;
- visibility, fog, smoke and haze; and
- air stability, mixing heights and ventilation coefficients.

The locations of the monitoring stations relative to the proposed mill site and characteristics of the available data are listed in Table 2.1. The four stations are relatively equally spaced from the site, 30 - 40 km distant. Emphasis was placed on the assessment of data from the Lac La Biche Station, because:

- It is the closest station to the mill site having air and precipitation records.
- Wind data are not available from the Wandering River, Calling Lake and Athabasca Stations.
- Slave Lake is 130 km distant compared to 55 km for Lac La Biche. In addition, the Slave Lake Station is in a valley and wind directions are affected in that they tend to be from west to northwest in the summer and east to southeast in winter with little variation between these directions.

It should be noted that the station at Lac La Biche is an automatic system; there is no one at the site on a routine basis and visibility, fog, haze and smoke readings are not readily available. The STAR data rely on visual observations and hence there are no STAR data for Lac La Biche. Therefore, the STAR data from Slave Lake were used in the sulphur dispersion modelling (SULDEP3).

Table 2.1 Climate data available from stations near the mill site.

Station	Data Availability		Approximate Distance from Proposed Plant Site
Lac La Biche	Wind (1958-80) Temperature Precipitation	(22 years) (14 years) (15 years)	40 km/ESE
Athabasca	Precipitation Temperature	(41 years) (41 years)	30 km/SW
Calling Lake	Precipitation Temperature	(11 years) (11 years)	30 km/NNW
Wandering River	Precipitation Temperature	(5 years) (5 years)	30 km/NNE

2.1 TEMPERATURE, PRESSURE AND RELATIVE HUMIDITY

Summary data for temperature, pressure and relative humidity are given in Table 2.2.

The mean daily temperature ranges from -18.7°C in January to 16.1°C in July. The mean daily maximum and minimum temperatures in January are -13.3°C and -24.1°C ; in July the range is 10.0°C to 22.3°C . The lowest recorded temperature is -48.3°C and the maximum temperature recorded is 33.9°C .

Atmospheric pressure variations are quite small, ranging from a low of 94.53 kPa in June (at 19:00 hours) to 94.97 kPa in January (at 13:00 hours).

Relative humidity ranges from 71% (May) to 89% (August and September) during morning hours (7:00 hours). Afternoon humidity measurements

Table 2.2 Temperature, pressure and humidity data for Lac La Biche

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Mean Daily Temp. °C	-18.7	-12.9	-7.2	3.2	9.7	13.9	16.1	14.7	9.3	4.6	-6.2	-14.2	1.0
Maximum Daily Temp. °C	-13.3	-6.9	-1.1	9.4	16.5	20.3	22.3	20.7	15.0	10.0	-1.8	-9.4	6.8
Minimum Daily Temp. °C	-24.1	-18.9	-13.2	-3.1	2.9	7.4	10.0	8.6	3.6	-0.9	-10.6	-18.9	-4.8
Extreme Maximum Temp. °C	11.7	13.9	17.2	24.4	30.0	33.9	32.8	31.1	30.0	27.2	14.4	11.7	33.9
Extreme Minimum Temp. °C	-48.3	-46.7	-44.4	-22.8	-11.7	-3.3	2.2	-2.2	-8.3	-15.0	-40.0	-40.6	-48.3
Days of Frost (day)	31	28	30	26	9	1	0	0	7	21	30	31	214
Atmospheric Pressure K Pa													
7:00 hr	94.96	94.80	94.85	94.74	94.80	94.66	94.84	94.77	94.77	94.60	94.66	94.78	94.77
13:00 hr	94.97	94.78	94.84	94.69	94.74	94.59	94.80	94.73	94.74	94.57	94.66	94.76	94.74
Relative Humidity %													
7:00	83	84	85	79	71	77	84	89	89	84	85	84	83
13:00	77	75	70	52	46	54	58	60	61	59	75	79	64
Dew Point °C													
7:00	-21.4	-17.2	-13.6	4.5	1.8	8.0	11.5	10.2	4.0	-1.7	-10.6	-17.0	4.2
13:00	-20.4	-15.3	-9.0	-3.5	1.6	7.8	11.6	10.8	5.5	-0.3	-8.3	-14.6	-2.7

drop significantly and range from 46% (May) to 79% (December) at 13:00 hours. The relative humidity is higher during the winter months when the capacity of the air to hold moisture is low.

2.2 PRECIPITATION

Precipitation data for Lac La Biche are given in Table 2.3. Total annual precipitation averages 483.5 mm and consists of 356.9 mm of rain and 126.6 mm rain equivalent of snowfall. (The total precipitation is obtained by adding the annual rainfall in millimeters and 1/10th of the annual snowfall in millimeters).

On average, there are 110 days per year on which rain or snow falls, 60 days when rain falls and 53 days when snow falls. The maximum rainfall (and also the maximum precipitation) in a 24 hour period is 81.5 mm (June); the maximum snowfall in 24 hours is 23.6 cm (May).

The highest average monthly rainfall occurs in July (106.7 mm) with June (70.8 mm) and August (75.7 mm) being the next highest months. Between October and April, rainfall is much lower, ranging from 0.1 mm to 8.5 mm.

Snow falls in nine months of an average year with June, July and August being the only snow-free months. The maximum monthly accumulation, 24 cm/month, is in December.

Calculated maximum 24-hour rainfall intensities for the mill site are shown below.

Return period (years)	Rainfall intensity (mm/hr)
2	1.9
10	2.9
50	3.8
100	4.2

Table 2.3 Precipitation data for Lac La Biche

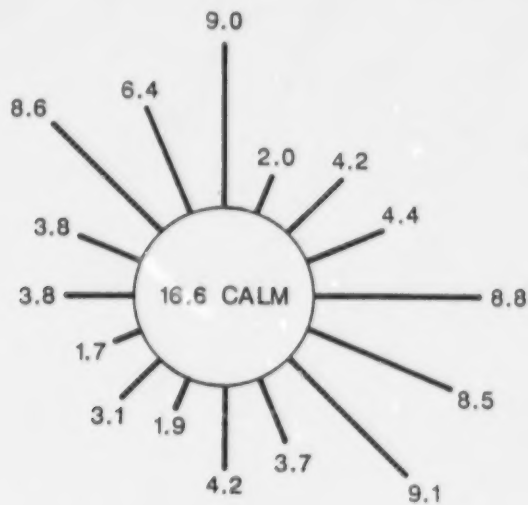
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Rainfall (mm)	0.4	0.4	0.6	8.4	33.5	70.8	107.7	75.7	47.9	8.5	2.9	0.1	356.9
Snowfall (cm)	21.5	19.5	18.4	11.5	3.8	0	0	0	4.3	7.2	16.4	24.0	126.6
Total precipitation (mm)	20.8	18.1	17.9	20.0	39.0	70.8	106.7	76.7	48.3	17.2	18.9	22.7	476.1
Greatest 24 hour rainfall (mm)	6.6	3.8	2.5	13.7	30.5	81.5	62.7	71.6	35.8	10.2	11.2	0.8	81.5
Greatest 24 hour snowfall (cm)	17.0	15.2	18.5	13.2	23.6	0	0	0	20.3	23.4	14.5	14.5	23.6
Greatest 24 hour precipitation (mm)	17.0	15.2	18.5	19.1	30.5	81.5	62.7	71.6	35.8	26.9	15.0	11.4	81.5
Number of days with rain	0	0	0	3	7	11	14	11	9	4	1	0	60
No. of days with snow	11	9	9	3	1	0	0	0	1	2	7	10	53
No. of days with precipitation	10	9	9	5	7	11	14	11	10	6	8	10	110

Table 2.4 Wind direction frequency (percent) 1958-1980
Lac La Biche

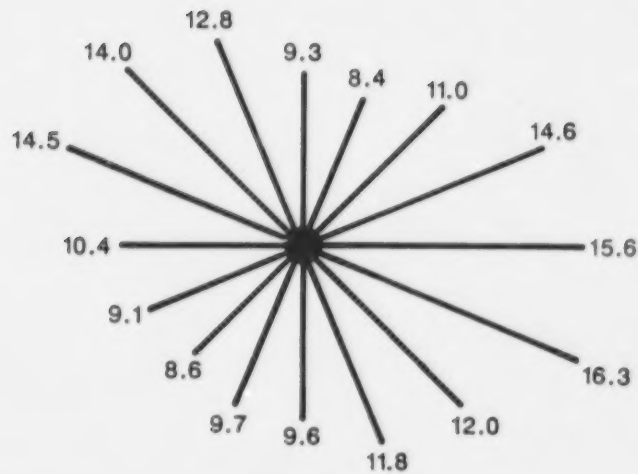
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
N	4.8	4.1	4.9	5.6	16.2	4.9	3.0	2.9	3.8	2.7	4.1	3.8	4.2
NNE	1.5	1.6	2.7	3.2	4.2	2.3	1.4	1.3	1.5	0.8	1.1	1.4	1.9
NE	2.0	2.2	3.9	4.0	6.5	4.8	2.9	3.1	3.2	1.6	2.2	1.3	3.1
ENE	0.7	0.8	1.3	1.9	3.4	3.3	2.1	2.0	2.1	1.2	1.1	0.6	1.7
E	2.8	3.3	3.8	4.1	5.4	5.7	4.5	4.0	3.3	2.5	4.0	2.2	3.8
ESE	3.5	4.1	5.3	4.1	5.3	4.9	3.3	3.3	2.4	2.8	2.7	4.0	3.8
SE	8.6	10.4	11.1	9.1	8.4	6.1	6.0	6.6	6.2	9.0	8.5	12.7	8.6
SSE	5.8	9.7	7.6	8.8	5.5	3.7	3.1	4.0	4.4	7.9	8.0	7.7	6.4
S	7.6	11.1	9.2	11.2	6.9	6.0	5.7	7.1	9.5	11.5	12.9	9.6	9.0
SSW	1.2	1.7	1.5	2.7	2.3	2.4	1.9	2.5	2.8	2.9	2.9	1.7	2.2
SW	3.0	3.1	3.5	3.8	3.1	3.8	4.2	5.3	4.8	5.2	5.4	3.7	4.2
WSW	3.5	3.8	3.1	4.2	3.1	3.9	5.9	5.9	4.3	6.8	4.9	3.7	4.4
W	5.9	6.6	6.4	6.5	6.5	10.2	13.3	11.7	10.6	12.3	8.9	6.5	8.8
WNW	9.2	5.7	6.6	6.2	7.2	9.3	10.5	9.8	11.5	10.7	7.7	7.6	8.5
NW	11.7	9.9	9.3	8.6	8.8	8.9	8.8	7.5	9.8	8.3	7.7	10.4	9.1
NNW	4.9	4.2	4.3	4.6	4.4	3.2	2.2	2.2	3.8	2.9	3.9	3.8	3.7
Calm	23.3	17.7	15.7	11.4	12.8	16.6	20.2	20.8	16.0	10.9	14.0	19.3	16.6

Table 2.5 Wind speed (km/hr) 1958 - 1980
Lac La Biche

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
N	9.3	9.9	9.7	10.6	10.6	9.9	8.1	8.2	9.8	9.9	10.1	8.7	9.6
NNE	8.8	9.3	9.2	11.2	9.8	11.1	8.7	8.6	10.2	9.9	10.2	9.1	9.7
NE	8.0	7.9	8.4	10.0	9.6	9.2	7.8	8.6	9.3	9.2	8.5	7.1	8.6
ENE	7.9	8.3	8.3	9.0	10.7	9.8	9.1	9.7	10.0	9.4	10.0	6.7	9.1
E	9.9	8.2	8.9	12.2	12.0	11.1	10.0	11.1	11.5	10.6	10.4	9.4	10.4
ESE	13.2	12.2	14.9	15.2	17.9	16.1	13.7	15.0	13.4	15.9	13.4	12.6	14.5
SE	13.0	12.6	15.5	15.5	16.3	14.5	13.4	13.2	14.4	15.1	12.7	12.2	14.0
SSE	12.1	12.3	13.8	14.4	14.4	13.0	12.3	11.4	12.3	13.8	12.4	11.9	12.8
S	8.2	9.0	9.4	11.2	10.9	10.0	8.8	8.5	9.4	9.3	8.7	7.9	9.3
SSW	8.1	10.1	8.0	11.6	10.9	8.9	7.8	7.8	9.3	8.6	8.8	7.2	8.9
SW	10.2	10.9	10.9	12.6	12.3	10.4	10.5	10.1	10.7	11.5	11.4	10.8	11.0
WSW	15.0	15.1	13.7	14.6	15.1	14.7	13.8	14.3	13.9	14.6	14.4	15.6	14.6
W	15.1	16.3	15.0	16.3	16.4	15.7	15.0	14.5	15.6	16.7	15.7	15.4	15.6
WNW	16.5	15.8	16.9	17.9	17.1	14.9	13.5	13.5	15.8	17.9	18.1	17.2	16.3
NW	11.7	12.3	12.9	13.2	13.2	11.1	10.4	10.0	12.1	12.9	12.4	12.1	12.0
NNW	12.4	12.0	11.9	12.8	12.4	10.7	10.4	9.1	12.6	12.7	13.0	12.0	11.8
All Directions	9.3	9.9	10.5	11.9	11.7	10.4	9.4	9.2	10.6	12.1	10.6	9.6	10.4
Maximum Hourly Speed	48	60	48	56	51	48	64	60	80	68	56	56	80
and Direction	NNW	NNW	Several	W	WNW	W	SW	WNW	W	W	WNW	WNW	W
Maximum Gust	77	97	72	89	89	89	89	89	113	97	129	89	129
Speed and Direction	NNN	NNW	Several	W	SW	W	SW	SW	W	W	WSW	WNW	WSW



MEAN WIND DIRECTION (%)



MEAN WIND SPEED (km/h)

Appendix 2

Figure 2.1

WIND ROSES FOR LAC LA BICHE

2.3 WINDSPEED AND DIRECTION

Wind velocity and direction frequency data are given in Tables 2.4 and 2.5, and in Figure 2.1.

There are two general prevailing wind directions: from the west to the northwest during summer and early fall, and from the south to the southeast in the late fall, winter and early spring. The most prevalent wind direction throughout the year is from the northwest (9.1% of the time). This frequency ranges from 7.5% (August) to 11.7% (January). The next most prevalent direction frequencies are from the south (9.0%), the west (8.8%), the southeast (8.6%) and the west-northwest (8.5%). During the period June to October the winds are primarily from the west (10.2% - 13.3%), west-northwest (9.3% - 11.5%) and the northwest (7.5% - 9.8% of the time). From October to April the prevailing winds blow from the south (7.6% - 12.9%), the south-southeast (5.8% - 9.7%) and southeast (8.5% - 11.1% of the time).

The average annual windspeed is 10.4 km/hour and ranges from 9.2 km/hour in August to 12.1 km/hour in October. The maximum average annual windspeeds are associated with the westerly winds, 16.3 km/hour (west-northwest), 16.5 km/hour (west) and 14.6 km/hour (west-southwest).

The maximum hourly wind speed recorded is 80 km/hour for west winds in the month of September and the peak gust windspeed recorded is 129 km/hour from the west-southwest in November.

Calms, which are associated with minimal dispersion of pollutants, are the most prevalent wind condition and occur on an annual average of 16.6% of the time, ranging from a low of 10.9% frequency in October to a high of 23.9% in January.

2.4 VISIBILITY

Fogs occur relatively infrequently, 17 days per year on average. The maximum number of occurrences (3) is in August. Winter fogs are relatively uncommon and have a lower frequency during daytime hours.

There was one recorded occurrence of haze/smoke per year during approximately 14 years of observations.

2.5 LOCAL METEOROLOGICAL DATA

A meteorological station (Site 2) was set up close to the proposed mill site as part of a research project carried out by the Alberta Environmental Research Centre. Wind speed and direction data and precipitation data were collected during the months of May - September for the years 1985, 1986 and 1987. Summary data are given in Table 2.6.

Table 2.6 Weather data from Site 2

Year	Precipitation (mm)			Wind Speed (km/h)			Wind Direction		
	'85	'86	'87	'85	'86	'87	'85	'86	'87
May (partial)	11	-	26	8.6	-	10.5	N,NW		
June	48	67	50	11.2	11.6	11.0	W		
July	66	149	60	8.3	8.4	8.0	W,NW		
August	38	15	65	9.1	8.1	8.0	W,SW		
September (partial)	19	4	-	10.9	8.2	-	-		

The availability of data from the station provided an opportunity to compare "on-site" data with that from the Lac La Biche Station. Wind speed and direction data compare quite well, indicating that Lac La Biche wind data are appropriate for use for the mill site. Average temperatures at the Site 2 station also compare quite well with those at the Lac La Biche station. The precipitation data, however, do not correlate well, precipitation measurements at Site 2 being lower than those for Lac La Biche. This may be due to the short period of sampling at the site and the dry summers in recent years. (The Lac La Biche precipitation data are for a 15 year period).

2.6 DISPERSION METEOROLOGY

Mixing and dispersion of atmospheric pollutants occurs in both vertical and horizontal directions. Good vertical mixing relies on unstable atmospheric conditions while horizontal transport and dispersion is a function of wind speed and direction, air turbulence, and topography.

The change in air temperature with pressure and altitude is known as the lapse rate of the atmosphere and is an important factor in the vertical transport, mixing and dilution of air pollutants. In mixed air, the dry adiabatic lapse rate is 5.4°F per 1,000 ft. (0.98°C per 100 m); that is, for every 100 meters of vertical rise, the air temperature decreases by 0.98°C. This temperature gradient results in air movement, unstable atmospheric conditions and good mixing of the air.

Frequently the lapse rate of the atmosphere is greater or less than adiabatic. When the lapse rate is greater than adiabatic (superadiabatic) the air is very unstable and mixing efficiency increases. Conversely, when the lapse rate is sub-adiabatic the atmosphere is stable and vertical movement and mixing is limited. In

extreme circumstances when the lapse rate is negative, the temperature of the upper air is greater than that at ground level, vertical movement and turbulence are suppressed, the air is very stable and an inversion results. This condition is of particular interest in air pollution dispersion investigations, since it places a limit on vertical dispersion. Inversions of two main types, termed surface and elevated, may occur.

Radiation or surface inversions occur most frequently, usually at night when skies are clear and the winds are light. Solar heating during the day results in high ground surface temperatures during the late morning and afternoon leading to an unstable atmospheric condition. Maximum mixing heights usually occur in mid-afternoon. However, at night, thermal radiation to the cold night sky cools the ground surface and the air adjacent to it. A radiation inversion occurs with the air aloft being warmer than the surface air. With the appropriate relative humidity, these conditions can lead to the formation of fog which normally burns off quickly during the morning. Both cloud cover and strong winds suppress the tendency for formation of radiation inversions. The winds result in mechanical turbulence which tends to smooth out the temperature gradient.

Elevated inversions exist above the ground surface and act as a barrier between the mixed layer close to the surface and that aloft. These elevated inversions can be caused by:

- subsidence, the gradual descent of air aloft accompanied by adiabatic warming;
- sea-breeze, the introduction of a colder layer of air beneath a warmer air mass; or
- a meteorological front in the atmosphere or boundary between cold air below and warm air aloft.

Stability in the bottom 300 m or so of the atmosphere usually shows considerable diurnal variations. Normally, the temperature decreases with height during the day and causes unstable atmospheric conditions. At night the temperature increases with height, stable atmospheric conditions are generated, and the potential for the formation of inversions exists.

The main height is a measure of the vertical distance available for the mixing of pollutants primarily by the action of atmospheric turbulence. As noted above, this height usually reaches a maximum value in the afternoon.

The mean windspeed through the mixing height is calculated by vertical averaging of the windspeeds observed at 12:00 GMT at the surface and at the standard pressure levels up to or immediately below the top of the mixing layer.

The ventilation coefficient is a product of the mixing height and mean windspeed, and provides a useful measurement of dispersion conditions. The higher the ventilation coefficient, the greater the ability of the atmosphere to disperse materials emitted into it. The coefficient is expressed in square metres per second (m^2/sec); however, it represents the volumetric rate per unit distance normal to wind direction ($\text{m}^3/\text{sec m}$) at which the air within the mixing layer is transported.

For good mixing, values of the afternoon ventilation coefficients should exceed $6,000 \text{ m}^2/\text{sec}$.

The mixing height, windspeed and ventilation coefficient data given in Tables 2.7, 2.8 and 2.9 show that dispersion conditions are enhanced during spring and summer. Winter months have the lowest ventilation coefficients with values below $2,000 \text{ m}^2/\text{sec}$.

Table 2.7 Lee of the Rockies Region - mixing heights

Mixing Heights (m)	Percentage Frequencies (Mean)				Annual
	Spring	Summer	Fall	Winter	
0 - 200	5.2	1.9	9.8	37.2	13.5
201 - 400	9.7	2.3	13.7	36.7	15.6
401 - 600	8.7	3.4	11.7	11.4	15.6
601 - 800	6.6	5.1	9.9	6.3	7.0
801 - 1000	5.2	3.7	8.3	2.5	5.0
1001 - 1200	6.6	5.3	7.9	1.4	5.3
1201 - 1400	4.6	4.4	7.3	1.4	4.4
1401 - 1600	4.9	6.4	7.0	0.6	4.7
1601 - 1800	5.6	5.1	5.0	0.5	4.1
1801 - 2000	4.8	6.8	5.8	0.8	4.6
20.1	38.3	55.7	13.7	1.1	27.2

Source: Environment Canada

Table 2.8 Lee of the Rockies Region - mean wind speed

Mixing Speed (m/s)	Percentage Frequencies (Mean)				Annual
	Spring	Summer	Fall	Winter	
0 - 4.0	21.7	2.15	20.5	47.6	27.8
4.1 - 8.0	40.9	49.8	45.1	30.8	41.7
8.1 - 12.0	26.6	22.3	22.4	12.6	21.0
12.1 - 16.0	8.7	5.6	8.9	6.5	7.4
16.1 - 20.0	2.2	0.8	2.4	2.0	1.9
+ 20.1	0.3	0.0	0.6	0.5	0.4

Source: Environment Canada

Table 2.9 Lee of the Rockies Region - ventilation coefficients

Ventilation Coefficient (m ² /sec x 10 ³)	Percentage Frequencies (Mean)				Annual
	Spring	Summer	Fall	Winter	
0 - 1.0	8.6	1.9	12.5	46.7	18.2
1.1 - 2.0	7.9	3.0	10.8	20.0	10.4
2.1 - 3.0	6.8	4.7	8.1	8.5	7.0
3.1 - 4.0	5.8	5.5	8.0	5.2	6.1
4.1 - 5.0	4.5	4.2	5.1	2.4	4.1
5.1 - 6.0	3.6	4.6	5.9	2.4	4.1
6.1 - 7.0	3.6	3.3	5.6	1.0	3.4
7.1 - 8.0	4.9	4.4	3.5	1.9	3.7
8.1 - 9.0	3.5	4.5	3.3	1.1	3.1
9.1 - 10.0	4.0	4.8	3.5	1.7	3.5
10.1 - 11.0	1.9	3.8	3.6	1.0	2.6
+ 11.1	45.1	55.4	30.0	5.4	34.0

Source: Environment Canada



3.0 STACK DISPERSION MODELLING

3.1 INTRODUCTION

The Alberta Environment "STACKS" dispersion model was used to determine maximum ground level concentrations of gaseous emissions from the Alberta-Pacific mill. The "STACKS" model is a simple dispersion model that considers "worst" conditions and has a number of simplifying assumptions:

- all the stack sources are considered to be in a straight line,
- topographic features below the level of the base of the stacks are considered to be at the base of the stack,
- a single topographic feature such as a hill can be taken into account,
- it is one dimensional model,
- a single tree canopy can be taken into account, given the height of the trees and the distance from the emission sources.

The model does not take local meteorological conditions into account. It uses a mixing height of 100 m (or specific value selected) and examines maximum ground level concentrations and their locations for wind speeds varying from 1 m/sec to 20 m/sec.

The following parameters were input to the model:

- stack height,
- stack diameter,
- stack gas exit speed,
- stack gas temperature,
- pollutant emission rate at a given reference temperature,
- reference temperature,
- distance of the stack from a specified origin,
- height of tree canopy,
- distance of tree canopy from a specified origin, and
- ambient temperature.

The model determines the maximum ground level concentration (or tree top concentration), its distance from the source, and the wind speed under which this would occur.

The model also determines the contribution of each emission source to the maximum concentration and effective stack heights under the conditions selected.

The following information was used as input to the model:

- provisional plant layout for the relative locations of the stacks and the distances between them,
- provisional plant location, surrounding topographic features and location of tree canopies,
- provisional stack data and emission data.

The gaseous emission data used in the modelling process are summarized in Table 3.1.

3.2 HYDROGEN SULPHIDE

Maximum expected emissions under normal operating conditions were modelled and the following four stacks were included:

- recovery stack
- lime kiln
- smelt tank
- slaker scrubber

The calculated overall maximum tree top concentration was 0.001 ppm as a one hour average, located 1318 m downwind from the origin (specified as the location of the lime kiln) at a 2.5 m/sec critical wind speed. (The tree canopy was considered to be 20 m high and 850 m from the emission sources).

Table 3.1 Atmospheric emission modelling data

Stack	Height Diam. (m)	Exit Speed (m/s)	Flow (m ³ /s)	Molst. (%)	Temp (°C)	H ₂ S		SO ₂		NO _x		CL ₂		ClO ₂		Partic.		
						ppm	kg/d	ppm	kg/d	ppm	kg/d	ppm	kg/d	ppm	kg/d			
Recovery boiler	100	4.0	17.0	93.3	26	195	6.5	80	600	13840	50	830	-	-	-	90	726	
Power boiler	100	4.0	14.4	83.3	24	170	-	-	50	1030	80	1180	-	-	-	240	1730	
Lime kiln	43	1.4	18.0	11.5	25	180	10.0	15	30	85	100	204	-	-	-	130	129	
Sewelt tank	75	1.6	17.0	14.3	44	85	22.3	42	-	-	-	-	-	-	-	215	266	
Slaker scrubber	30	1.5	18.0	3.9	90	90	13.7	7	-	-	-	-	-	-	-	135	46	
Bleach plant	50	1.6	1.6	2.5	80	75	-	-	-	-	-	-	32	22	108	65	-	
Chemical prep.	50	1.6	1.6	3.3	35	20	-	-	-	-	-	-	18	16	43	35	75	22

The overall contribution of each emission source to this maximum value is as follows:

Recovery stack	0.000 ppm
Lime kiln	0.000 ppm
Smelt tank	0.001 ppm
Slaker scrubber	0.000 ppm

The largest emission source was the recovery stack (79.6 kg/day H_2S), but the high stack (100 m) and the relatively high stack temperature (195°C) result in an effective stack height of 165 m and effective dispersion of the pollutant.

In the case of the smelt tank stack, the height is 75 m, the effective height is 91 m (below the specified mixing layer height of 100 m), and the stack temperature is 85°C, resulting in a less dispersed plume compared to the recovery stack and a greater contribution to the overall maximum concentration of hydrogen sulphide, despite a pollutant emission rate (42 kg/day) only about half that from the recovery stack.

Additional investigations were carried out for a tree canopy 2000 m distant and 20 m high. Results indicate no difference in maximum concentrations at tree top level (0.001 ppm H_2S) at a location 2089 m from the origin.

Thus, using the "STACKS" model and four hydrogen sulphide emission sources, the maximum calculated hydrogen sulphide concentration at tree top level is 0.001 ppm, well below the prescribed maximum one hour ground level concentration of 0.010 ppm.

Vent Streams

The low volume, high concentration (LVHC) vent stream is estimated at 2800 kg/day H_2S . This vent stream is incinerated in the lime kiln and converted to sulphur dioxide. The quantity of sulphur dioxide emitted from the lime kiln includes this vent stream; therefore, dispersion modelling of this stream is not required.

The high volume low concentration vent stream (HVLC) is estimated at 300 kg/day H_2S . This stream is directed to the recovery boiler and converted to sulphur dioxide; the quantity of sulphur dioxide emitted from the recovery boiler takes into account this vent stream.

3.3 SULPHUR DIOXIDE

The following emission sources were included in the "STACKS" model:

- | | |
|------------------|----------------------|
| - recovery stack | 13,837 kg/day SO_2 |
| - lime kiln | 85 kg/day |
| - power boiler | 1,030 kg/day |

The modelling results indicated that the maximum ground level concentration occurred approximately 3000 m from the emission sources; therefore, a tree canopy 20 m high and 2000 m from the sources was used.

Based on the expected maximum emission rates during normal mill operations for sulphur dioxide, the maximum tree top concentration of sulphur dioxide is 0.030 ppm.

The contribution of each source to this maximum concentration is as follows:

Recovery stack	0.028 ppm	
Lime kiln	0.000 ppm	
Power boiler	0.002 ppm	2-3.5

Thus it may be concluded that the maximum sulphur dioxide concentration will be well below the prescribed ambient one hour limit of 0.170 ppm.

3.4 CHLORINE/CHLORINE DIOXIDE

The two sources of chlorine and chlorine dioxide emissions are:

- bleach plant
- chemical preparation.

Dispersion calculations were carried out using stack information and emission data provided. Maximum ambient concentrations were developed at tree top level and gave the following results:

Chlorine	0.004 ppm
Chlorine Dioxide	0.011 ppm

It is anticipated that Alberta Environment will set limits for maximum ambient concentrations of chlorine and chlorine dioxide based on Ontario standards, which are:

Chlorine	0.10 ppm (1 hour)
Chlorine Dioxide	0.03 ppm (1 hour)

The calculated maximum ground level concentrations of chlorine and chlorine dioxide are well below these anticipated standards.

3.5 OXIDES OF NITROGEN

The following sources of oxides* of nitrogen were considered in the dispersion model:

- recovery boiler
- power boiler
- lime kiln

Preliminary estimates indicated that oxides of nitrogen concentrations in the stack gases would be as follows:

Recovery stack	50 ppm
Power boiler	80 ppm
Lime kiln	100 ppm

Maximum concentrations of oxides of nitrogen were calculated at a tree top height of 20 m, 2000 m from the emission sources. The maximum concentration was 0.007 ppm, contributions from each stack being as follows:

Recovery boiler	0.002 ppm
Power boiler	0.003 ppm
Lime kiln	<u>0.001</u> ppm
Total	0.007 ppm

This maximum value (0.007 ppm) is well below the prescribed maximum one hour ground level concentration of 0.21 ppm.



4.0 SULPHUR DEPOSITION

Total (wet plus dry) sulphur deposition resulting from operation of the proposed mill was assessed using the Alberta Environment "SULDEP III" model.

Only one emission source was used, that is, sulphur dioxide emissions from the recovery stack. Sulphur dioxide emissions from this source are an order of magnitude greater than the other sources of sulphur dioxide, as shown in the following table:

Emission Source	Sulphur Dioxide Emissions (kg/day)
Recovery stack	13,837
Lime kiln	85
Smelt tank	35
Power Boiler	1,030

It is recognized that hydrogen sulphide, when emitted to the atmosphere, is converted to sulphur dioxide; however, hydrogen sulphide emissions were not considered in the assessment of sulphur deposition since these emissions are small in comparison with the sulphur dioxide emissions from the recovery stack, as shown below:

Emissions Source	Hydrogen Sulphide Emissions (kg/day)	Equivalent Sulphur Dioxide Emissions (kg/day)
Recovery stack	79.6	150
Lime kiln	15.1	28
Smelt tank	42	.079
Slaker scrubber	7.0	13.0

The stack parameters input to the "SULDEP III" model were those used as inputs to the "STACKS" dispersion model and included in Table 3.1.

Precipitation information was based on data obtained for Slave Lake and the Slave Lake STAR data were also used.

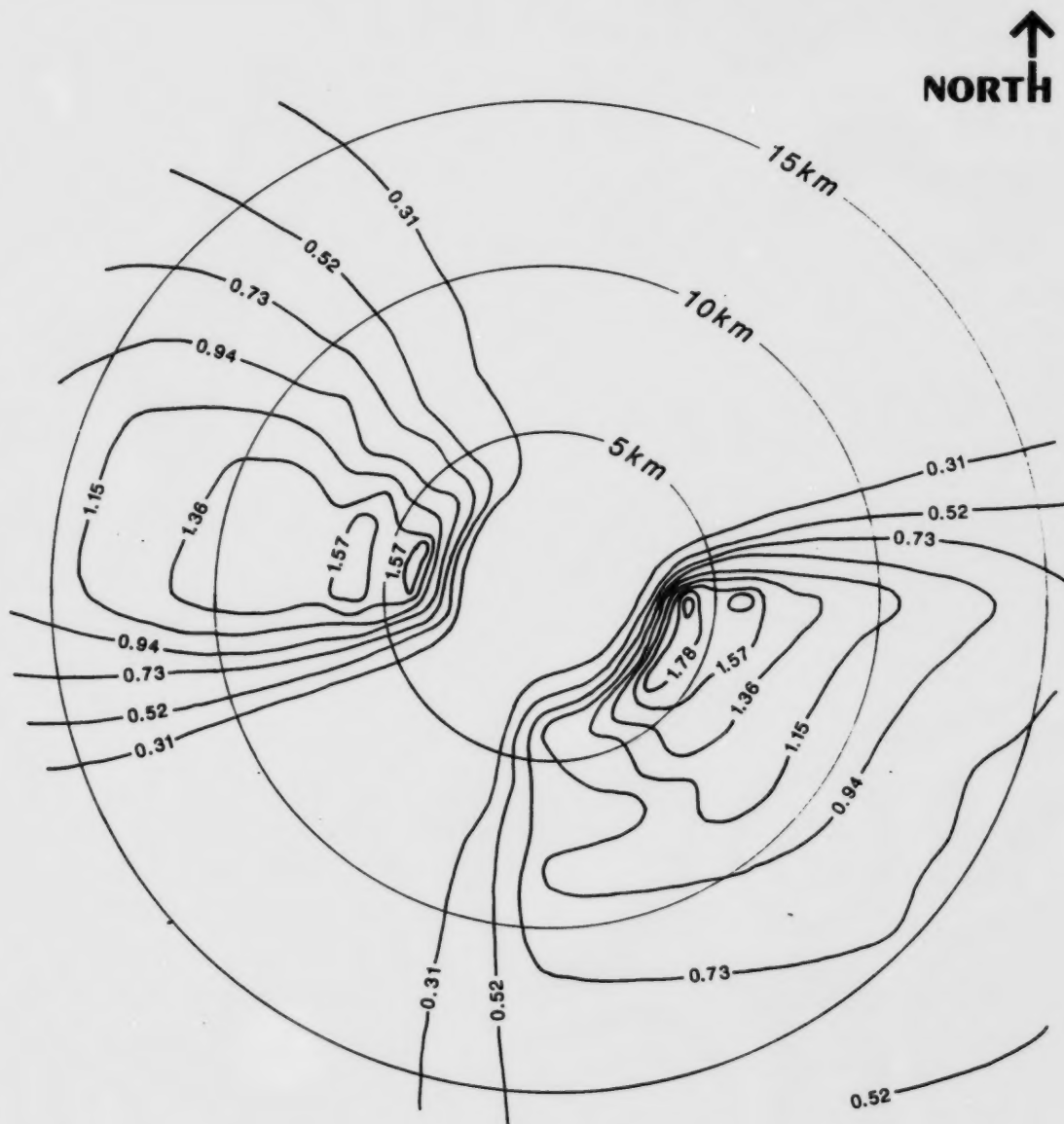
Seasonal mean temperatures were based on data from the Slave Lake Meteorological Station and mean maximum mixing heights for the four seasons for the year were taken from the published information for Alberta.

Seasonal mean temperatures were determined from data obtained from Slave Lake Meteorological Station.

The data output from SULDEP III provides tables of sulphur deposition as a function of distance and direction from the source. The SULDEP III data indicate that the greatest annual sulphur deposition occurring as a result of mill air emissions will be 2.1 kg/ha/year at a point approximately 4 km east of the mill site. Areas of higher sulphur deposition, shown in Figure 4.2, correspond to the prevailing wind directions and are generally west to west-northwest and east to southeast of the mill site. Deposition rates beyond the limits of Figure 4.2 are summarized in Tables 4.1 and 4.2.

Approximately 10.4% of the total sulphur deposition is predicted to occur within a radius of 100 km of the mill site.

The ADEPT sulphur deposition model, which takes terrain variations into account, was used to confirm the SULDEP III output data. The patterns of deposition predicted by the two models were very similar and the maximum predicted deposition rate, 2.1 kg/ha/yr, was the same in each case.



Appendix 2

Figure 4.1

TOTAL SULPHUR DEPOSITION
(kg/ha/yr) IN THE VICINITY
OF THE MILL SITE

Table 4.1 Predicted maximum total sulphur deposition (kg/ha/yr) resulting from mill emissions, by distance and direction.

Distance from mill (km)	Direction from mill							
	N	NE	E	SE	S	SW	W	NW
20	0.11	0.03	0.52	0.44	0.39	0.05	0.70	0.42
30	0.07	0.01	0.30	0.26	0.23	0.03	0.41	0.25
40	0.09	0.02	0.24	0.18	0.17	0.02	0.32	0.23
50	0.06	0.01	0.17	0.13	0.13	0.02	0.24	0.17
60	0.05	0.01	0.13	0.10	0.10	0.01	0.18	0.13
80	0.03	0.01	0.09	0.07	0.06	0.01	0.12	0.08
100	0.02	0.01	0.06	0.05	0.05	0.01	0.09	0.06

Table 4.2 Predicted maximum total sulphur deposition at regional communities.

Community	Total sulphur deposition (kg/ha/yr)
Athabasca	0.02
Calling Lake	0.23
Wandering River	0.03
Plamondon	0.18
Grassland	0.51
Lac La Biche	0.10
Boyle	0.17
Amber Valley	0.31

5.0 AIR EMISSION STANDARDS AND STACK DISPERSION MODELLING

5.1 GENERAL CONSIDERATIONS

The Air Emissions Standards given in the following sections were provided to APFI during a recent meeting with Alberta Environment.

The following general comments are made:

1. The US EPA Standards are generally for a twelve hour average and it is understood that these have been converted by Alberta Environment to a four hour average.
2. A four hour average rather than one hour average is used for TRS because of inherent variability in the recovery boiler operation and the impracticality of specifying a one hour limit.
3. The unit "dsm³" is dry standard cubic metres. Standard conditions are 101.23 kPa and 25°C.
4. There is no limit on sulphur dioxide; the US EPA did not consider the available technology for sulphur dioxide control to be economically feasible.

Emission standards have been compared with the US EPA twelve hour standards for those considered by Alberta Environment to be applicable to the APFI operation.

5.1.1 Recovery Boiler

TRS	APFI	6.5 ppmv corrected to 8% oxygen (4-hour average)
	US EPA	5 ppmv corrected to 8% oxygen (12 hour average)

SO ₂	APFI	maximum concentration limit of 600 ppm and mass limit to be calculated from boiler design information
	US EPA	not specified
Particulates	APFI	0.10 g/dsm ³ corrected to 8% oxygen
	US EPA	0.10 g/dsm ³ corrected to 8% oxygen

5.1.2 Lime Kiln

TRS	APFI	10.0 ppmv corrected to 10% oxygen (4-hour average)
	US EPA	8 ppmv corrected to 10 oxygen (12-hours)
Particulates	APFI	0.15g/dms ³ corrected to 10% oxygen
	US EPA	0.15g/dms ³ corrected to 10% oxygen (gaseous fuel)
		0.30 g/dsm ³ corrected to 10% oxygen (liquid fuel)

5.1.3 Power Boiler

Alberta Environment uses the Emission Guidelines for Fossil Fuel Fired Thermal Generating Plants, issued in April 1984, as a basis for emission limits from the Power boiler, on the assumption that solid fuel is used to fire the power boiler.

Particulates

APFI	0.10 g/dsm ³ corrected to 8% oxygen 43 ng/J
Power Plant Guidelines	0.1 lbs/million btu (43 ng/J)

NO_x

APFI	258 ng/J
Power Plant	0.60 lbs/million btu (258 ng/J)
Guidelines	

5.1.4 Smelt Dissolving Tank

Alberta Environment bases the emission standard on the flow to the smelt tank. There is a possibility that this emission standard may change to a mass/unit emission standard in the future.

TRS

APFI	0.16 g/kg black liquor
------	------------------------

Particulates

APFI	0.10 g/kg black liquor solids
------	-------------------------------

5.1.5 Chlorine and Chlorine Dioxide

Maximum ambient limits for chlorine and chlorine dioxide are based on Ontario standards.

Chlorine	0.10 ppm (1-hour)
Chlorine dioxide	0.03 ppm (1-hour)

5.2 STACK EMISSION RATES

Stack dispersion calculations using the "STACKS" model provided by Alberta Environment were based on maximum expected emissions during normal mill operations. In view of the proposed air emission standards to be set for the APFI mill, it is appropriate to compare the proposed emission limits with the emissions used in the "STACKS" dispersion model program.

5.2.1 Hydrogen Sulphide (TRS)

A concentration of 6.5 ppm in the recovery boiler stack was used in the dispersion calculations, equal to the proposed prescribed limit.

A value of 10 ppm in the lime kiln stack gases was used in the dispersion calculations, equal to the proposed prescribed limit.

The proposed emission limit from the smelt tank is provided in terms of a mass of TRS emitted per unit weight of black liquor. The equivalency of this limit and the hydrogen sulphide concentration in the stack has yet to be determined.

Emission limits have not been proposed for the slaker scrubber.

5.2.2 Sulphur Dioxide Emissions

A maximum concentration limit of 600 ppm is expected to be set for the recovery boiler and this is equal to the concentration used in the 'STACKS' dispersion modelling program.

Sulphur dioxide emission rates are not set for the lime kiln; the calculated emissions from the lime kiln are an order of magnitude less than those from the recovery boiler.

Sulphur dioxide emission limits have not been set for the power boiler; calculated emission rates are orders of magnitude less than those from the recovery boiler.

5.2.3 Oxides of Nitrogen Emissions

The proposed emission limit is 258 ng/J or 0.6 lbs/million BTU. This is above the 0.2 lbs/million BTUs used in the original calculations on which the oxides of nitrogen concentrations in the power boiler stack were based.

5.2.4 Chlorine and Chlorine Dioxide

The expected prescribed limits are based on maximum one hour ground level concentrations of chlorine and chlorine dioxide for the province of Ontario.

5.2.5 Particulate Emissions

The anticipated particulate emission limits are based on concentrations rather than a quantity emission rate per unit time period.

A concentration of 90 mg/m³ was used in the stack dispersion modelling, which is of the same order as the anticipated maximum particulate limit for the recovery boiler.

The anticipated particulate limit for lime kiln emissions is 0.15 g/dsm³ (150 mg/m³), close to the particulate concentration of 130 mg/m³ used in the stack dispersion modelling as being representative of the maximum expected emissions during normal operations.

In regard to the power boiler, the anticipated prescribed limit is 0.10 g/dsm³ (100 mg/m³). This value is based on Alberta Environment use of the Guideline values for fossil fuel fire thermal generating plants on the basis that solid fuel is used to fire the power boiler. It is noted that a value of 240 mg/m³ was used in the stack dispersion modelling. This value is significantly higher than the anticipated prescribed limit and further consideration of these values is appropriate.

It is not expected that particulate emission limits will be set for the smelt tank, slaker scrubber and chemical preparation.

5.3 DISPERSION MODELLING FOR EXTREME CONDITIONS

The Alberta Environment SEEC (Search for the Extreme Ensemble Concentration) model was used to identify the magnitude and location of the highest concentrations and meteorological conditions under which they occur. Its primary use is to identify "worst case" meteorology by searching various meteorological combinations of wind speed, direction, and stability.

Modelling results indicate a maximum ground level concentration of 0.001 ppm hydrogen sulphide, under conditions of stability A or E and under conditions of low wind speed (1 m/s to 3 m/s). In all cases, the smelt tank stack was the largest contributor to the maximum ground level concentration of hydrogen sulphide (45 - 60% of the total value). The maximum hydrogen sulphide concentration (0.001 ppm) is the same value as that obtained using the "STACKS" dispersion model and is well below the maximum prescribed one hour ground level concentration limit for hydrogen sulphide of 0.010 ppm. It is also at or below the expected threshold odour level for hydrogen sulphide.

6.0

POTENTIAL IMPACTS OF THE PROPOSED DEVELOPMENTS

This summary of impacts of the proposed development on existing air quality is based on the dispersion analysis outlined in detail in previous sections of this report, taken in conjunction with existing limits for ambient concentration of primary pollutants and anticipated stack emission limits for specific pollutants.

6.1

STACK EMISSIONS

It is expected that emissions from the major stacks will result in ambient standards for primary pollutants (hydrogen sulphide, sulphur dioxide and particulates) not being exceeded. The dispersion analysis was based on inputs representing maximum emissions during normal operations and the results showed that the calculated ground levels of concentrations of pollutants were well below ambient standards.

Although long-term average ambient concentrations have not been addressed at the present time, indications are, using the Alberta Environment SEEC dispersion model to identify worst case meteorological conditions, that long-term ambient limits will not be exceeded.

It is expected that particulate emissions from the power boiler, lime kiln and recovery boiler will be low and that the electrostatic precipitator control equipment will be adequate to meet the emission standards set by Alberta Environment.

6.2

SULPHUR DEPOSITION

The Alberta Environment program SULDEP was used to estimate total (wet plus dry) annual sulphur deposition rates resulting from operation of the pulp mill. In using this program, it was assumed that sulphur emissions from the plant would be the maximum expected during normal process operations.

The recovery stack is the major source of sulphur emissions (approximately 14 tons per day) and other sulphur dioxide emission sources are orders of magnitude less than that from the recovery stack. Although hydrogen sulphide is converted in the atmosphere to sulphur dioxide, the emission sources of hydrogen sulphide are orders of magnitude less than emission sources of sulphur dioxide.

Based on the use of the SULDEP model, the maximum sulphur deposition rate is 2.1 kg/ha/yr in a location approximately 4 km east of the proposed mill site. Maximum values range from 1.6 to 2.1 kg/ha/yr in two distinct locations, west to west-northwest and east to southeast of the mill site. The maximum rate is about 7.5% of an estimated background deposition rate in the order of 28 kg/ha/yr, which is based on values of 28.5 kg/ha/yr at Edmonton and 27.1 kg/ha/yr at Fort McMurray (Palmer and Trew 1987).

Streams will not be affected by the small increase in sulphur deposition caused by the mill, as Alberta rivers in general are not susceptible to acidification (Legge 1988). Lakes in the area are generally well buffered against acidification because of high pH, alkalinity and calcium values and are rated as having low susceptibility to acidification, except for a small area of low to medium susceptibility northeast of Lac La Biche (Erickson 1987, Palmer and Trew 1987). Agricultural soils will not be affected by the added sulphur deposition because normal management practices greatly outweigh the effects of acidification in Alberta (Legge 1988). Some of the forest soils in the region, particularly the sandy, acidic soils and certain types of organic soils, have moderate to high susceptibility to acidification (Palmer and Trew 1987), and these may experience a slight incremental impact due to the increase in sulphur deposition.

6.3 ODOUR EMISSIONS

Odours will be maintained at minimum levels using modern processing technology. Part of the process design to minimize fugitive emissions

is to combine the vent streams into two separate streams, low concentration high volume vent stream and high concentration low volume vent stream, and burn them in the lime kiln and recovery boiler, respectively. Provision will be made for bypass to recovery boiler vents in the event of an emergency.

6.4 VISIBILITY

On a natural basis, frequency of fog, haze and smoke is very low in the vicinity of the mill site.

It is not expected that there will be significant smoke or particulates from normal operation of the mill. The proposed mill site is on a plateau and the terrain is generally flat within the vicinity of the mill and water vapour emissions during normal operations should dissipate.

6.5 HEALTH

A review of available information (Appendix 7) indicates that sulphur dioxide emissions from the mill will be below the levels that affect both normal persons and those with asthma, and that hydrogen sulphide emissions are too low to cause toxicological problems in humans or livestock.

Airborne particulate sulphuric acid, which results from the interaction of sulphur dioxide and water vapour, can have health implications for asthmatics; since the sulphur dioxide emission rates will be so low, however, the possibility of sulphuric acid-related health problems is remote.

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- Legge, A.H. 1988. The present and potential effects of acidic and acidifying air pollutants on Alberta's environment. Critical point I, 1988. Summary report. Prep. for the Acid Deposition Research Program by The Kananaskis Centre for Environmental Research, The University of Calgary, Calgary, Alberta. ADRP-B-16-88. 79 pp.
- Palmer, C.J. and D.O. Trew, 1987. The sensitivity of Alberta lakes and soils to acidic deposition. Overview report. Prep. for Alberta Environment.

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1.0 GEOLOGY AND SOILS

1.1 EXISTING ENVIRONMENT

Bedrock

Bedrock in the project area is the Cretaceous Lea Park Formation, which consists of relatively flat-lying beds of marine shale with siltstone layers and bentonite seams. Bedrock exposures are infrequent and are limited to the Athabasca River valley.

Physiography

Two main physiographic units may be defined in the project area: the Lac La Biche Plain and the Athabasca Valley.

The Lac La Biche Plain is characterized by level to gently rolling topography and low level local relief that seldom exceeds 10 m. Elevations range from 530 m above sea level to 640 m in the Lac La Biche Plain as a whole, and from 530 to 600 m in the project area.

The Athabasca Valley is an entrenched valley about 40 to 50 m deep and incised into bedrock. In the project area, the valley is about 300 to 500 m wide at river level and approximately 1000 m wide at the top of the valley walls. River level is about 495 m above sea level. Valley wall slopes vary from moderate to steep, and slumps occur where oversteepened valley walls have failed. An extensive area of slope failures occurs immediately north of the mill site, extending down a minor side drainage to the river bank.

Surficial Deposits

Surficial deposits in the vicinity of the project area have been described by Richard (1986). Additional information is available from the results of a preliminary geotechnical investigation of the mill site carried out during 1988.

Glacial Till

South of the mill site the dominant surficial material is glacial till expressed as a blanket of un-oriented ground moraine. In some areas, the till is covered by a veneer of sand. Some rather striking oriented morainal features do occur, particularly to the southwest of the mill site. These features are long, narrow drumlins or drumlinoids oriented along a south southwest to north northeast axis corresponding to the direction of ice flow during the last glaciation.

Glacial Outwash

Outwash deposits are localized and minor in extent. The proposed mill site coincides with the largest occurrence in the area.

Organic Material

Extensive areas of organic deposits occur throughout the area. These consist of muck and peat, generally from 1 to 3 m thick, in bogs and other poorly drained areas.

Lacustrine Deposits

Lacustrine deposits are fairly widespread. These are of two types: coarse and fine. The coarse-textured lacustrine deposits consist

primarily of sand and silty sand; the fine-textured deposits are primarily silt and clay 1 to 5 m thick.

Aeolian Deposits

Extensive areas of windblown materials 2 to 15 m thick are found near the Athabasca River, both on the north and the south bank. These aeolian deposits consist of sand reworked from older glaciofluvial and glaciolacustrine sediments, and include areas of blowouts and dunes.

Alluvial Deposits

Alluvial deposits of varying composition occur as terraces within the Athabasca River valley.

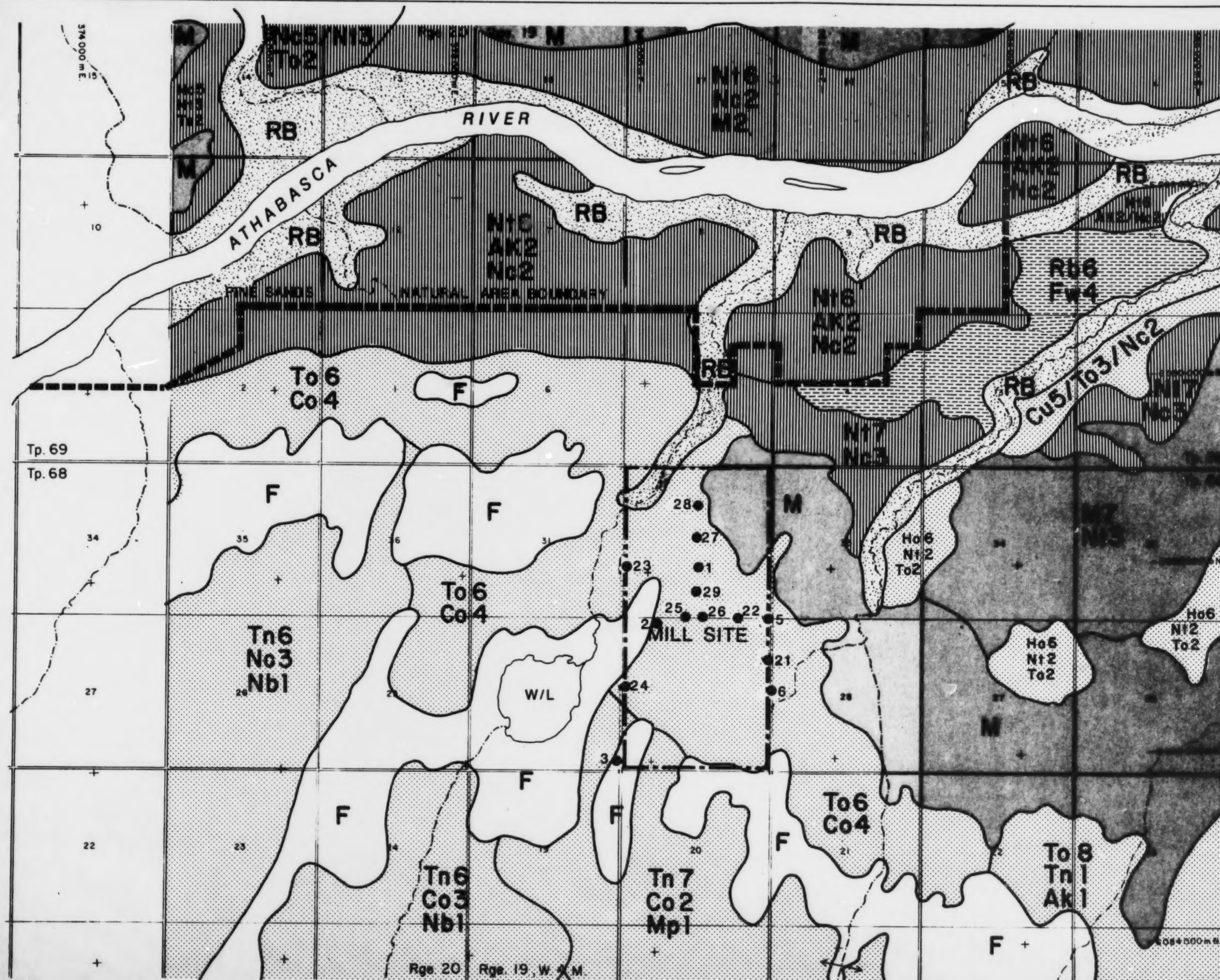
Bedrock

Bedrock outcrops occur along the banks of the Athabasca River. The bedrock unit mapped in Figure 1.1 includes colluvium and landslide material derived from both bedrock and non-bedrock sources.

Mill Site Conditions

Test hole data (Figure 2.1, Appendix 8) indicate that three main types of surficial materials occur in the mill site area. These materials are:

- dune sands of fine to medium texture and of very loose density.
- discontinuous outwash sands and gravels that are silty, poorly graded, of variable density, and generally of low to medium plasticity. The sands and gravels contain layers of silt and clay and in some locations are underlain by very dense, laminated fine sands and silts.



NORTH
↑

LEGEND

- 27 TEST HOLE
- [Solid Grey Box] MESISOL
- [White Box] FIBRISOL
- [Vertical Lines Box] BRUNISOLS
- [Horizontal Lines Box] LUVISOLS
- [Stippled Box] ROUGH AND BROKEN (REGOSOLS, BEDROCK)
- [Wavy Lines Box] CHERNOZEMS
- W/L WATER
- Tn6 etc. SOIL SERIES (SEE TABLE 1.1) AND DECIMAL PROPORTION OF UNIT

SCALE
0 500 1000 2000m

Appendix 3

Figure 1.1

SOILS



- thin layers of lacustrine clay that underlie the surficial sand soils at several locations. These materials are of medium to high plasticity and soft to firm consistency.

The total measured depth of these materials ranges from 3 to 14 m.

The surficial materials are almost invariably underlain by a clay till of very stiff to hard consistency that has been overconsolidated during past glacial history. Zones of very stiff to hard lacustrine clay or very dense fine sand occur within the till stratum. Where it is present, the till layer varies between 3 and 26 m in thickness. The till generally overlies bedrock, which occurs at depths of 8 to more than 30 m.

Soils

Soils in the project area (Figure 1.1) have been described and mapped in detail by Kjearsgaard (1972). The major soil types are closely correlated with the surficial deposits.

Luvisols

Orthic Gray Luvisols, which are well to imperfectly drained soils that develop under forest vegetation, are the dominant soils on till, lacustrine and outwash parent materials. Stoneless soils of the Tolman Series predominate on lacustrine deposits while the relatively stony Tawatinaw soils are characteristic on till materials. These soils have mainly a class 4 capability for agriculture (severe limitations that restrict the range of crops and/or require special conservation practices), although some of the lacustrine soils are rated class 3 (moderately severe limitations). Characteristics of the Tolman, Tawatinaw and other soil series are summarized in Table 1.1.

Table 1.1 Characteristics of main soil series affected by the project.

Soil Series	Soil Group	Texture	Parent Material	Drainage	Stoniness	Agricultural Capability	Vegetation
Ah	Athabasca	Orthic Gray Luvisol	loam	till	moderately well	3-5	AP/WS; BP, WB
Al	Amisk	Degraded Eutric Brunisol	loamy sand	aeolian	rapidly	6	JP
Cn	Codner	Orthic Humic Gleysol	loam, silt loam	alluvial lacustrine	imperfect	3-4	willow, shrubs
Co	Codesa	Degraded Eutric Brunisol Orthic Gray Luvisol	sandy loam, loamy sand	alluvial over till	well	4-5	AP/BP, WB/BS
F	Fibrisol	Fibrisol		organic	very poorly	-	BS, TA, LT, Sp
Fw	Fawcett	Dark Gray Luvisol	loam, silt loam	alluvial lacustrine	well	3	AP/WB
Gt	Grosmont	Dark Gray Luvisol	loam	till	moderately well	3	AP/BP, WB, WS
Gu	Gourin	Rego Dark Gray Chernozem	sandy loam	alluvial or aeolian	rapidly	4	AP, shrubs
Jv	Jarvie	Humic Eluviated Gleysol	loam, silt loam	alluvial lacustrine	poorly	4	shrubs, hydrophytic
M	Mesisol	Mesisol		organic	very poorly	-	BS, TA, LT, Sp
Mp	Mapova	Humic Eluviated Gleysol	loam	till	poorly	4	AP, BP, WB, BS, willow
Nb	Newbrook	Low Humic Eluviated Gleysol	loam	till	poorly	4	willow
Nc	Nicot	Degraded Eutric Brunisol Brunisolic Gray Luvisol	sandy loam, loamy sand	alluvial or aeolian	rapidly	5	AP/JP
Nt	Nestow	Degraded Dystric Brunisol	loamy sand	aeolian	rapidly	6	JP
Rb	Rimbey	Orthic Dark Gray Chernozem	loam, silt loam	alluvial lacustrine	well	3	AP
Sw	Sawdy	Humic Eluviated Gleysol	clay loam	lacustrine	poorly	5	willow
Tn	Tawatinau	Orthic Gray Luvisol	loam, sandy loam	till	well	4-5	AP/WS, WB
To	Tolman	Orthic Gray Luvisol	loam	alluvial lacustrine	well	3	AP/WB

AP - aspen; BP - balsam poplar; WS - white spruce; BS - black spruce, TA - tamarack; JP - jackpine; WB - white birch; LT - Labrador tea; Sp - sphagnum moss

Organic Soils

Organic soils have developed on the extensive areas of organic deposits. Organic soils contain 30% or more organic matter and are water saturated for most or all of the year if not artificially drained. In the project area, the organic soils are Fibrisols and Mesisols, which are separated by the degree of decomposition of organic matter. In Mesisols the organic matter is moderately decomposed, whereas in Fibrisols it is relatively undecomposed. Organic soils have no agricultural capability rating.

Brunisols

Brunisols are brownish coloured, are well to imperfectly drained, have good oxidizing conditions, and develop under forest vegetation. In the project area Brunisols are associated primarily with aeolian and some alluvial parent materials, the dominant soils being Degraded Dystric Brunisols of the Nestow Series. Brunisols developed on aeolian parent materials are highly susceptible to wind and water erosion once disturbed and have a low water retaining capacity. Capability for agriculture is rated as class 6 (very severe limitations that restrict soil capability to producing perennial forage crops, and improvement practices are not feasible).

Chernozems

Chernozems are the soils that develop on well to imperfectly drained sites under grassland or transitional forest-grassland vegetation cover. They are characterized by a prominent, dark-coloured surface Table 1.1 horizon. In the project area, Chernozems occur on alluvial and lacustrine parent materials to the northeast of the mill site. These are Orthic Dark Gray Chernozems of the Rimbey Series, with a class 3 agricultural capability.

Gleysols

Gleysols occur in poorly-drained, depressional areas and are consequently water saturated and under reducing conditions continuously or for part of the year. They support hydrophytic vegetation and may have organic surface layers up to 60 cm thick. Only one extensive area of Gleysols occurs in the project area, about 3 km south of the mill site. These soils, of the Sawdy Series, are Humic Eluviated Gleysols developed on lacustrine parent materials. The agricultural capability rating is 5 (restricted to producing perennial forage crops, and improvement practices are feasible).

Regosols

Regosols are poorly developed, immature soils that occur on recently deposited or frequently disturbed parent materials. In the project area Regosols occur primarily along the Athabasca River on recent alluvial and colluvial deposits. Their capability for agriculture rating is class 6.

1.2 IMPACTS

Terrain disturbance will arise from excavation and grading during site preparation and infrastructure construction. The amount of excavation required at the mill site is estimated to be in the order of 2,000,000 m³. Much of this amount will consist of sand and gravel that can be used for grading and construction purposes in areas other than the main mill block. Any clay materials removed will be stockpiled for use as lagoon liner. Topsoil will be stockpiled separately. The remainder of the excavated materials will be lightly compacted, graded to appropriate contours, and revegetated to prevent erosion. Limited terrain disturbance will also occur on the comparatively steep slopes near the Athabasca River, where the following facilities will be located: 1) effluent outfall, defoaming pond and access road; 2) intake

pumphouse and access road. These facilities will be designed so as to minimize terrain disturbance. Construction of the water intake and effluent pipelines will have minor effects on terrain, as the former will follow the edge of the existing Nova pipeline right-of-way, while the latter will follow existing roads, cutlines and agricultural land for most of its length. The likelihood of slope failures is low as no unstable slopes will be affected by any of the facilities. This will be confirmed by geotechnical investigations prior to construction.

Removal, burial and/or alteration of soil horizons will occur as a result of site preparation and infrastructure construction. The soil unit most affected will be the Tolman-Codesa complex, which covers most of the mill site. The characteristics of the different soil units that will potentially be affected by the project were given in Table 1.1. Topsoil will be salvaged during site preparation work and infrastructure construction for use in mill site landscaping. Topsoil salvage will be straightforward in areas of Chernozemic and Luvisolic soils, but the Brunisolic topsoils tend to be thin and sandy and may be difficult to salvage. Organic soils will also be difficult to salvage. Topsoil stockpiles will be seeded with an appropriate mixture of grasses and legumes to prevent erosion.

Wind erosion is of concern in the sandy Brunisols of the aeolian landforms, and disturbed soils in these areas will therefore be promptly revegetated. The condition of the existing Nova pipeline right-of-way indicates that good revegetation success can be achieved. Water erosion is a potential concern in all inorganic soil horizons, particularly on sloping ground. Water erosion will be minimized by maintenance of surface drainage control, construction stop-work orders during extremely wet weather if necessary, and application of appropriate erosion control and reclamation techniques to disturbed areas. Riverbank erosion will be prevented at the water intake and effluent discharge facilities by armouring as required.

Most of the soils in the vicinity of the mill are moderately to highly resistant to acidification (Legge 1988, Palmer and Trew 1987); however, some of the sandy, aeolian soil series such as the Nestow and Amisk are susceptible to acidification. Sulphur deposition from the mill, which will create an increase of about 7.5% in current sulphation rates in the zone of maximum deposition (Appendix 2), may cause some slight incremental acidification in these soils.

2.0 VEGETATION

2.1 EXISTING ENVIRONMENT

Information on vegetation was derived from Alberta Forest Service Phase III forest cover maps (1:15,000 scale), from 1:30,000 black and white aerial photographs, from 31 ground truthing points examined during a reconnaissance field survey (29 August 1988), and from published and unpublished reports. The field survey included the mill site, the water intake and effluent outfall locations, and the raw water and effluent treatment pipeline rights-of-way.

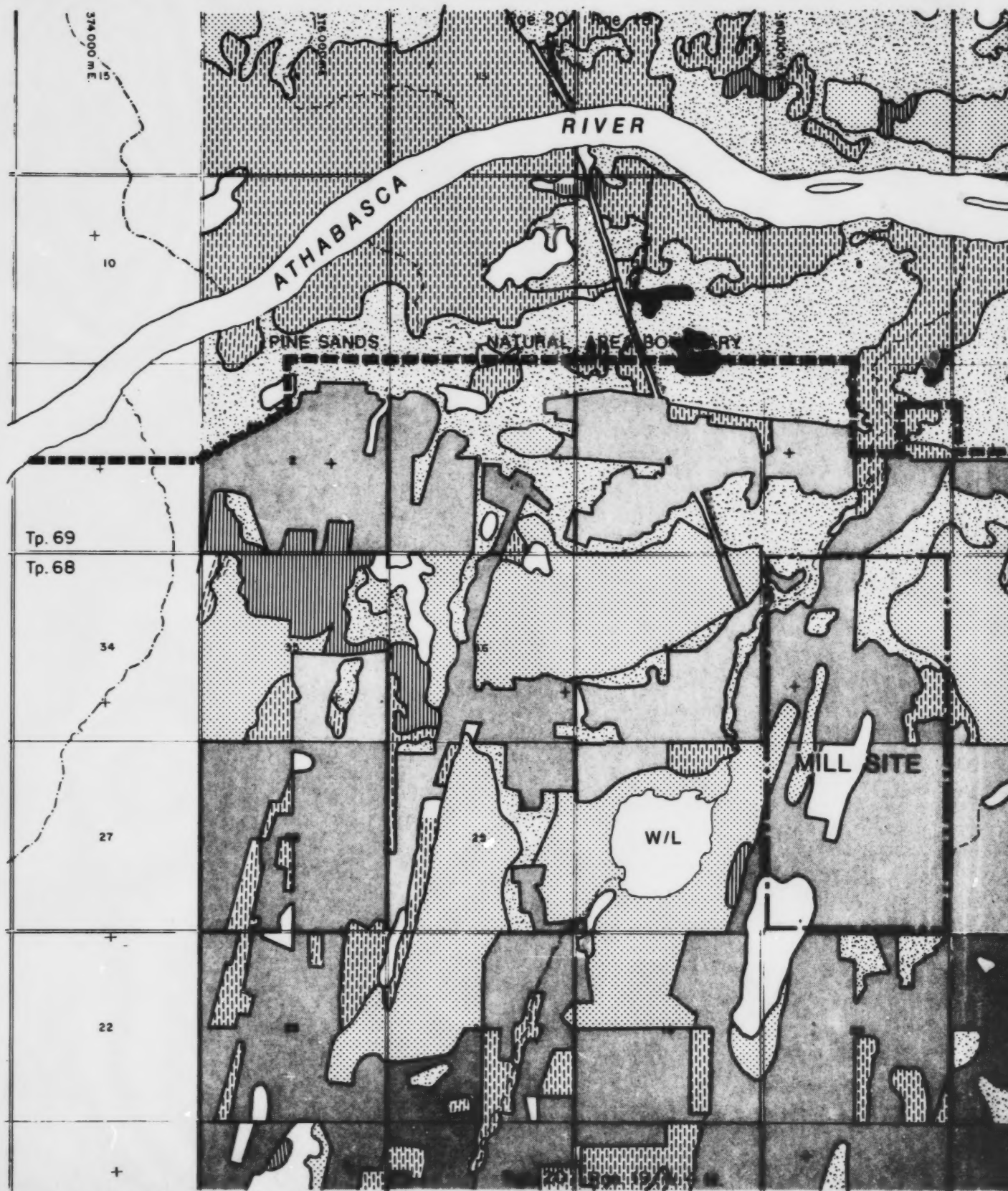
The mill site is located within the dry mixedwood subregion of the boreal mixedwood ecoregion of Alberta (Strong and Leggat 1980). This ecoregion comprises 43% of the province and is dominated by aspen (Populus tremuloides) with secondary quantities of balsam poplar (Populus balsamifera), jackpine (Pinus banksiana), white spruce (Picea glauca) and black spruce (Picea mariana) forest. The dry boreal mixedwood subregion represents a transitional zone between the moist mixedwood subregion to the north and the aspen parkland region to the south.

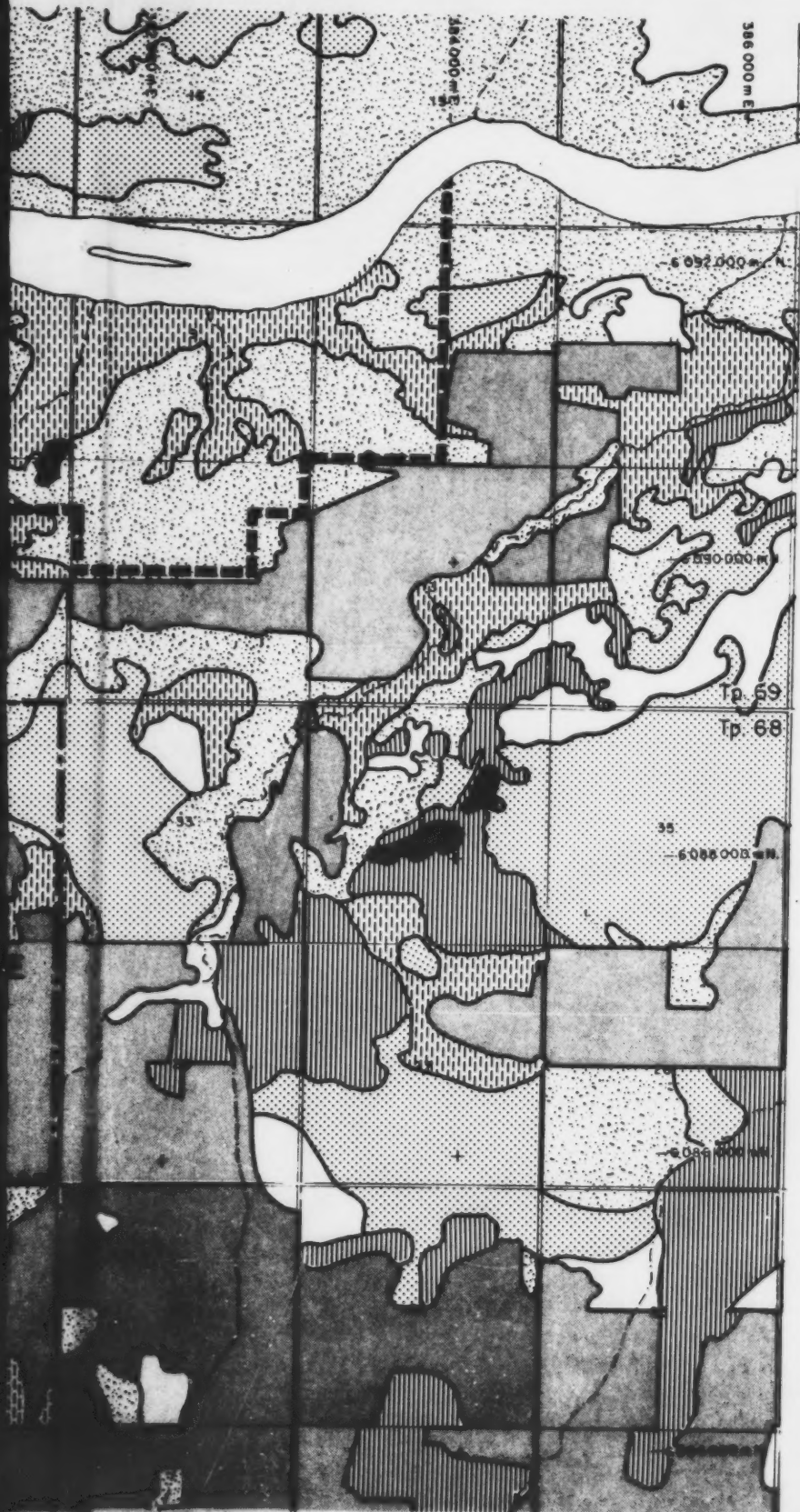
The predominant forest cover types in the project area are pure aspen stands and aspen-dominated mixedwood stands containing either white spruce or jackpine. Other significant forest cover types include riverine balsam poplar, white and/or black spruce, pure jackpine, and black spruce/tamarack (Larix laricina) bogs. Non-forested cover types include shrublands, open muskeg (sedge meadows), and cultivated or other cleared land.

Table 2.1 lists some of the typical vegetation cover types near the mill site, including commonly occurring understory shrub and forb species. These vegetation assemblages are consistent with similar types reported for the dry boreal mixedwood subregion by Kocaoglu and

Table 2.1 Vegetation cover types occurring in the project area.

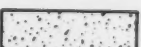
Cover Type Description	Dominant Shrubs	Dominant Herbs
Dry Aspen Forest	Rose, Saskatoon, Snowberry, Hazel	Firewood, Aster, Bedstraw, Peavine, Blueberry, Bearberry
Moist Aspen Forest	Honeysuckle, Red-Osier Dogwood, Low-Bush Cranberry, Raspberry	Horsetail, Peavine, Fireweed Sarspavilla, Coltsfoot
Riverine Balsam Poplar Forest	Red-Osier Dogwood, Low-bush Cranberry	Horsetail, Aster, Bunchberry
Paper Birch Forest	Alder, Chokecherry	Vetch, Graminoids
Mixedwood Forest (Aspen, White Spruce, Balsam Poplar)	Alder, Low-bush Cranberry, Rose, Dogwood, Honeysuckle, Saskatoon	Bunchberry, Horsetail, Fireweed, Twinflower, Dewberry, Wild Sarsaparilla
Jackpine Sandplain Forest	Prickly Rose, Saskatoon	Bearberry, Reindeer Lichen, Junegrass, Northern Bedstraw
Larch Wetland	Dwarf Birch, Labrador Tea, Willow	Bog Cranberry, Dewberry, Lousewort, Sedge, Sphagnum Moss
Black Spruce Wetland	Willow, Dwarf Birch, Labrador Tea	Bog cranberry, Dewberry
White Spruce Forest	Alder, Labrador Tea, Currant	Feathermoss, Twinflower, Horsetail, Bog Cranberry, Fireweed
Riverine Shrub	Sandbar Willow, Red-Osier Dogwood	Horsetail, Reedgrass
Shrub Wetland	Willow, Dwarf Birch	Sedge, Dewberry, Angelica





↑
NORTH

LEGEND

-  CONIFEROUS - SPRUCE
OR SPRUCE & PINE
-  PINE
-  TAMARACK/BLACK SPRUCE
& TREED MUSKEG
-  SHRUBS & OPEN MUSKEG
-  MIXED DECIDUOUS & CONIFEROUS
-  ASPEN (& BALSAM POPLAR)
-  CULTIVATED & OTHER
CLEARED LAND
-  W/L WATER

SCALE

0 500 1000 2000m

Appendix 3

Figure 2.1

VEGETATION/HABITAT

Bennet (1983) and by Kjearsgaard (1972). The correspondence of vegetation types with soil units is given in Table 1.1 of Section 1.1. Figure 2.1 shows the distribution of these vegetation types.

Closed aspen stands characterized by a dense, shrubby understory occur throughout the project area. Typical shrub species are prickly rose (Rosa acicularis), snowberry (Symphoricarpos albus), saskatoon or serviceberry (Amelanchier alnifolia), low bush cranberry (Viburnum edule) and hazelnut (Corylus cornuta) on drier sites, and red osier dogwood (Cornus stolonifera), alder (Alnus tenuifolia), twining honeysuckle (Lonicera involucrata), gooseberry (Ribes spp.) and willow (Salix spp.) on moister sites. The relatively undeveloped herb layer typically includes aster (Aster ciliolatus), fireweed (Epilobium angustifolium), northern bedstraw (Galium boreale), sarsaparilla (Aralia nudicaulis), wild peavine (Lathyrus ochroleucus), horsetail (Equisetum spp.), strawberry (Fragaria virginiana), meadow-rice (Thalictrum venulosum) and vetch (Vicia americana). Grasses are infrequent or absent except in clearings.

Mixedwood stands also occur throughout the project area. The dominant tree species are aspen and white spruce, with paper birch (Betula papyrifera) and balsam poplar occurring in the moister stands. The species composition of the shrub layer is similar to that of the aspen forest type; bunchberry (Cornus canadensis), wild sarsaparilla, horsetail, fireweed, twinflower (Linnaeus borealis) and dewberry (Rubus pubescens) are common herbs.

The riverine balsam poplar type is a mixedwood stand restricted to a narrow belt along the Athabasca River. White spruce and aspen may be present in the canopy. The shrub layer is typically dense, red osier dogwood being the principal species. Lowbush cranberry and rose are also common. Typical herbs include horsetail, aster, bunchberry,

Canada violet (Viola canadensis), and dewberry. This vegetation type occurs in too narrow a band to be mapped on Figure 2.1.

Pure spruce stands have relatively open shrub layers in which alder, Labrador tea (Ledum groenlandicum) and currant (Ribes spp.) are the main species. The herb layer is characterized by low plants such as horsetail, twinflower and bog cranberry (Vaccinium vitis-idaea). This vegetation type is localized and of limited extent within the project area.

Open to semi-closed jackpine stands, sometimes including aspen, occur on well-drained sandy soils in the project area. Mature stands are open and park-like. Shrub understories in this forest type are relatively undeveloped, varying from virtually absent to a scattered cover of rose, chokecherry (Prunus virginiana), saskatoon and blueberry (Vaccinium myrtilloides). Ground vegetation usually forms a continuous cover and is characterized by bearberry (Arctostaphylos uva-ursi), bog cranberry, June grass (Koeleria macrantha), hairy wild rye (Elymus innovatus) and rice grass (Oryzopsis pungens). Ground lichens such as Cladonia gracilis and Cladonia mitis are common. This vegetation type is similar to the pine/bearberry/lichen type of Kocaoglu and Bennet (1982).

Open tamarack and black spruce forests typify the poorly-drained portions of the project area. Scrub birch (Betula glandulosa), Labrador tea and various willows are the main components of the shrub layer, which is often dense. The dwarf shrub/herb layer is characterized by bog cranberry, cloudberry (Rubus chamaemorus), sedges (Carex spp.) and coltsfoot (Petasites palmatus, P. sagittatus). Sphagnum moss is abundant in this vegetation type, which corresponds to the tamarack/birch/sedge/moss unit described by Kocaoglu and Bennet (1983).

The wetland shrub stands in the project area lack tree cover and are dominated by dwarf birch and willow. The ground vegetation is similar to that found in the tamarack/black spruce wetland forest stands. The wetland shrub type is transitional with open muskeg, which occurs in the most poorly drained areas. Sedges are the characteristic plants on these wet sites.

Rare plants that may conceivably occur within the project area are listed in Table 2.2, which includes all of the rare species listed by Packer and Bradley (1984) as potentially occurring within the Boreal Mixed Wood Ecoregion. Two-thirds of the species listed are hydrophytic plants associated with water and wetlands. A systematic search for rare plant species was outside the scope of the present study, and no such search has previously been conducted in the project area. No rare plant species were seen during the August 29 field survey or during a previous survey of the Pine Sands Natural Area (AFLW 1988).

2.2 IMPACTS

Site clearing and infrastructure construction will result in the permanent removal of some native vegetation cover, although much of the land affected has already been cleared for agriculture. The vegetation communities involved appear to have no particular intrinsic value. Clearing for the water intake and effluent pipelines will be minor: the former will follow the edge of the existing Nova pipeline right-of-way, while the latter will follow an existing road, agricultural land, and an existing cutline for virtually its entire length.

Vegetation within the Pine Sands Natural Area will be slightly affected by the project. Construction of the water intake and cooling water return pipelines will necessitate clearing of a strip of vegetation approximately 40 m wide and 2 km long along the western edge of the

Table 2.2 Rare plants of the Boreal Mixed Wood Ecoregion

Species	Habitat
<u>Hydrophytic Plants</u>	
<i>Cardamine pratensis</i>	bogs and swamps
<i>Carex lacustris</i>	marshes and swampy woods
<i>C. lolicea</i>	marshes and sphagnum bogs
<i>C. trisperma</i>	muskeg and bogs
<i>C. vulpinoidea</i>	swampy ground
<i>Elantaine triandra</i>	muddy shores and shallow water
<i>Eleocharis compressa</i>	sandy shores and marshy ground
<i>Eupatorium purpureum</i>	wet meadows and thickets
<i>Hypericum majus</i>	moist depressions in sand dunes, sandy shores
<i>Juncus brevicaudatus</i>	shores and marshes
<i>Malaxis monophylla</i>	bogs, banks and damp woods
<i>M. paludosa</i>	black spruce bogs, in sphagnum moss
<i>Nymphaea tetragona</i>	ponds and quiet waters
<i>Plantago maritima</i>	saline marshes
<i>Polygala pauciflora</i>	marshy coniferous woods
<i>Potamogeton obtusifolius</i>	lakes, ponds, cold springs, streams
<i>Rynchosperma capillacea</i>	calcareous bogs
<i>Sagittaria latifolia</i>	ponds and lakes
<i>Scirpus clintonii</i>	marshy ground and turfy shores
<i>S. cyperinus</i>	marshy ground
<i>S. rufus</i>	saline marshes
<i>Spartina pectinata</i>	saline shores and marshes
<u>Other Plants</u>	
<i>Aster umbellatus</i>	moist woods, thickets and meadows
<i>Carex adusta</i>	moist sandy soil under pine, stony ground
<i>C. deflexa</i>	dry open woodland
<i>Danthonia spicata</i>	open areas, open woodland
<i>Geranium carolinanum</i>	dry rocky wood, disturbed sites
<i>Luzula acuminata</i>	moist woodland, clearings
<i>Monotropa hypopitys</i>	moist woods
<i>Oryzopsis micrantra</i>	dry open areas and sandy woodlands
<i>Selaginella rupestris</i>	exposed sandy sites
<i>Viola selkirkii</i>	moist woods
<i>Woodsia glabella</i>	shaded cliffs

existing NOVA gas pipeline right-of-way. Some vegetation loss will also occur at the western tip of the Natural Area along the right of way of the new western access road route proposed by Alberta Transportation.

It is not known whether any rare plant species will be affected by the project, although there is no reason to suppose that this would be the case.

Maximum ground level concentrations of gaseous emissions from the mill will be well below the standards set by Alberta Environment (Appendix 2) and therefore no impacts on vegetation are anticipated from this source.



3.0 WILDLIFE

3.1 EXISTING ENVIRONMENT

3.1.1 Introduction

The project area is located within the distributional ranges of as many as 223 wildlife species, including 175 birds, 42 mammals, 5 amphibians and 1 reptile. As a detailed wildlife inventory was outside the scope of this study, and as there is no pre-existing wildlife inventory information specific to the project area, a process of objectively evaluating the importance of wildlife species and habitats was used. This system was implemented as follows:

Review of Existing Literature

Species lists for the project area were drawn up by analysis of the available literature (Stebbins 1966, Salt and Salt 1976, Hay and O'Leary 1988, Penner and Ealey 1985) and fur and big game harvest data from Alberta Fish and Wildlife records. Only bird species that are expected to breed within the project area were included in the list.

Selection of Management Indicator Species

An evaluation system adapted from Green et al. (1984) was used in order to select the species that could be considered as management indicators. In order to keep the analysis to a reasonable size, a subset of species or families that were considered to be of priority were chosen from the lists. This selection was based on the species' prevalence in the study area and on species concerns that were identified in other reports.

The lists were also checked for species that the Alberta Fish and Wildlife Division and/or the Committee on Endangered Wildlife in Canada (COSEWIC) consider to be endangered, threatened or vulnerable (Culbert 1987, World Wildlife Fund 1987).

Seven criteria were used to rate each species or family on a 4 - point scale, as shown below:

<u>Criteria</u>	<u>Ranking values and rationale</u>
1. Political importance	Based on relative abundance and degree of management concern 3. Endangered species 2. Threatened/vulnerable species 1. Species abundant but some concern 0. Species abundant and no concern
2. Economic importance; commercial	Based on trapping and guiding revenue 3. High 2. Moderate 1. Low 0. Nil
3. Economic importance; subsistence	Based on subsistence hunting 3. High 2. Moderate 1. Low 0. Not hunted for food
4. Recreational importance; consumptive	Based on recreational hunting 3. High 2. Moderate 1. Low 0. Non-game species
5. Recreational importance; non-consumptive	Based on wildlife viewing, photography or aesthetic value 3. High 2. Moderate 1. Low 0. Nil

<u>Criteria</u>	<u>Ranking values and rationale</u>
6. Ecological factors; importance	Based on degree to which species is involved in or contributes to nutrient cycling, the food chain or physical maintenance of the ecological community 3. High 2. Moderate 1. Low
7. Ecological factors; vulnerability	Based on a species' dependence on certain vulnerable habitats and inability to use alternate habitats 3. High 2. Moderate 1. Low

Management indicator species were selected on the basis of the totals of their ranking values.

Scoring of Sensitive Wildlife Habitat

The different vegetation types in the study area were ranked on a scale of 0 - 3 for each Management Indicator Species (0 = inadequate habitat; 1 = poor habitat; 2 = moderate habitat; 3 = best habitat). Ratings were based on the ability of the vegetation type to provide each species with the essential life requisities of food and thermal, reproductive and escape cover. Cumulative habitat (vegetation type) suitability scores were obtained by summing the scores of each species for each vegetation type.

3.1.2 Management Indicator Species

Species lists for the study area are shown in Tables 3.1 - 3.3. Thirty-four species or families were chosen to be evaluated by the 7

Table 3.1 Bird species likely breeding within the project area.

Common Name	Latin Name
Red-necked Grebe	Podiceps grisegena
Horned Grebe	Podiceps auritus
Eared Grebe	Podiceps nigricollis
Pied-billed Grebe	Podilymbus podiceps
Western Grebe	Aechmophorus occidentalis
Double-crested Cormorant	Phalacrocorax auritus
Great Blue Heron	Ardea herodia
American Bittern	Botaurus lentiginosus
Canada Goose	Branta canadensis
Mallard	Anas platyrhynchos
Gadwall	Anas strepera
Pintail	Anas acuta
Green-winged Teal	Anas crecca
Blue-winged Teal	Anas discors
American Widgeon	Anas americana
Northern Shoveler	Anas clypeata
Redhead	Aythya americana
Ring-necked Duck	Aythya collaris
Canvasback	Aythya valisineria
Lesser Scaup	Aythya affinis
Common Goldeneye	Bucephala clangula
Bufflehead	Bucephala albeola
White-winged Scoter	Melanitta deglandi
Surf Scoter	Melanitta perspicillata
Ruddy Duck	Cryura jamaicensis
Common Merganser	Mergus merganser
Goshawk	Accipiter gentilis
Sharp-shinned Hawk	Accipiter striatus
Red-tailed Hawk	Buteo jamaicensis
Broad-winged Hawk	Buteo platypterus
Swainson's Hawk	Buteo swainsoni
Golden Eagle	Aquila chrysaetos
Bald Eagle	Haliaeetus leucocephalus
Marsh Hawk	Circus cyaneus
Osprey	Pandion haliaetus
Merlin	Falco columbarius
American Kestrel	Falco sparverius

Table 3.1 Continued

Common Name	Latin Name
Spruce Grouse	Canachites canadensis
Ruffed Grouse	Bonasa umbellus
Sharp-tailed Grouse	Pedioecetes phasianellus
Gray Partridge	Perdix perdix
Sandhill Crane	Crus canadensis
Virginia Rail	Rallus limicola
Sora	Porzana carolina
Yellow Rail	Coturnicops noveboracensis
American Coot	Fulica americana
Killdeer	Charadrius vociferus
American Avocet	Recurvirostra americana
Common Snipe	Capella gallinago
Upland Sandpiper	Bartramia longicauda
Spotted Sandpiper	Actitis macularia
Solitary Sandpiper	Tringa solitaria
Greater Yellowlegs	Tringa melanoleuca
Lesser Yellowlegs	Tringa flavipes
Short-billed Dowitcher	Limodromus griseus
Marbled Godwit	Limosa fedoa
Wilson's Phalarope	Steganopus tricolor
Herring Gull	Larus argentatus
California Gull	Larus californicus
Ring-billed Gull	Larus delawarensis
Franklin's Gull	Larus pipixcan
Bonaparte's Gull	Larus philadelphia
Common Tern	Sterna hirundo
Black Tern	Chlidanias niger
Mourning Dove	Zenaida macroura
Great Horned Owl	Bubo virginianus
Hawk Owl	Surnia ulula
Barred Owl	Strix varia
Great Grey Owl	Strix nebulosa
Long-eared Owl	Asio otus
Short-eared Owl	Asio flammeus
Boreal Owl	Aegolius funereus
Saw-whet Owl	Aegolius acadicus

Table 3.1 Continued

Common Name	Latin Name
Common Nighthawk	Chordeiles minor
Ruby-throated Hummingbird	Archilochus colubris
Belted Kingfisher	Megaceryle alcyon
Common Flicker	Colaptes auratus
Pileated Woodpecker	Dryocopus pileatus
Yellow-bellied Sapsucker	Sphyrapicus varius
Hairy Woodpecker	Picoides villosus
Downy Woodpecker	Picoides pubescens
Black-backed Three-toed Woodpecker	Picoides arcticus
Northern Three-toed Woodpecker	Picoides tridactylus
Eastern Kingbird	Tyrannus tyrannus
Eastern Phoebe	Sayornis phoebe
Say's Phoebe	Sayornis saya
Yellow-bellied Flycatcher	Empidonax flaviventris
Alder Flycatcher	Empidonax alnorum
Least Flycatcher	Empidonax minimus
Western Wood Pewee	Contopus sordidulus
Olive-sided Flycatcher	Nuttallornis borealis
Horned Lark	Eremophila alpestris
Tree Swallow	Iridoprocne bicolor
Bank Swallow	Riparia riparia
Barn Swallow	Hirundo rustica
Cliff Swallow	Petrochelidon pyrrhonota
Purple Martin	Progne subis
Gray Jay	Perisoreus canadensis
Blue Jay	Cyanocitta cristata
Black-billed Magpie	Pica pica
Common Raven	Corvus corax
Common Crow	Corvus brachyrhynchos
Black-capped Chickadee	Parus atricapillus
Boreal Chickadee	Parus hudsonicus
Red-breasted Nuthatch	Sitta canadensis
Brown Creeper	Certhia familiaris

Table 3.1 Continued

Common Name	Latin Name
House Wren	Troglodytes aedon
Winter Wren	Troglodytes troglodytes
Long-billed Marsh Wren	Cistothorus palustris
Ruby-crowned Kinglet	Regulus calendula
American Robin	Turdus migratorius
Hermit Thrush	Catharus guttatus
Swainson's Thrush	Catharus ustulatus
Veery	Catharus fuscescens
Mountain Bluebird	Sialia currucoides
Gray Catbird	Dumetella carolinensis
Sprague's Pipit	Anthus spragueii
Bohemian Waxwing	Bombycilla garrulus
Cedar Waxwing	Bombycilla cedrorum
Loggerhead Shrike	Lanius ludovicianus
European Starling	Sturnus vulgaris
Solitary Vireo	Vireo solitarius
Red-eyed Vireo	Vireo olivaceus
Philadelphia Vireo	Vireo philadelphicus
Warbling Vireo	Vireo gilvus
Black-and-White Warbler	Mniotilta varia
Tennessee Warbler	Vermivora peregrina
Orange-crowned Warbler	Vermivora celata
Yellow Warbler	Dendroica petechia
Magnolia Warbler	Dendroica magnolia
Cape May Warbler	Dendroica trigrina
Yellow-rumped Warbler	Dendroica coronata
Black-throated Green Warbler	Dendroica virens
Bay-breasted Warbler	Dendroica castanea
Blackpoll Warbler	Dendroica striata
Palm Warbler	Dendroica palmarum
Ovenbird	Seiurus aurocapillus
Northern Waterthrush	Seiurus noveboracensis
Connecticut Warbler	Oporornis agilis
Mourning Warbler	Oporornis philadelphia
Common Yellowthroat	Geothlypis trichas
Wilson's Warbler	Wilsonia pusilla
Canada Warbler	Wilsonia canadensis
American Redstart	Setophaga ruticilla

Table 3.1 Continued

Common Name	Latin Name
Western Tanager	<i>Piranga ludoviciana</i>
Rose-breasted Grosbeak	<i>Pheucticus ludovicianus</i>
Savanna Sparrow	<i>Passerculus sandwichensis</i>
LeConte's Sparrow	<i>Ammodramus leconteii</i>
Sharp-tailed Sparrow	<i>Ammodramus caudacuta</i>
Vesper Sparrow	<i>Poocetes gramineus</i>
Dark-eyed Junco	<i>Junco hyemalis</i>
Chipping Sparrow	<i>Spizella passerina</i>
Clay-coloured Sparrow	<i>Spizella pallida</i>
White-throated Sparrow	<i>Zonotrichia albicollis</i>
Fox Sparrow	<i>Passerella iliaca</i>
Lincoln's Sparrow	<i>Melospiza lincolni</i>
Swamp Sparrow	<i>Melospiza georgiana</i>
Song Sparrow	<i>Melospiza melodia</i>
Western Meadowlark	<i>Sturnella neglecta</i>
Yellow-headed Blackbird	<i>Xanthocephalus xanthocephalus</i>
Red-winged Blackbird	<i>Agelaius phoeniceus</i>
Northern Oriole	<i>Icterus galbula</i>
Rusty Blackbird	<i>Euphagus carolinus</i>
Brewer's Blackbird	<i>Euphagus cyanocephalus</i>
Common Grackle	<i>Quiscalus quiscula</i>
Brown-headed Cowbird	<i>Molothrus ater</i>
Evening Grosbeak	<i>Hesperiphona vespertina</i>
Purple Finch	<i>Carpodacus purpureus</i>
Pine Siskin	<i>Carduelis pinus</i>
American Goldfinch	<i>Carduelis tristis</i>
Red Crossbill	<i>Loxia curvirostra</i>
White-winged Crossbill	<i>Loxia leucoptera</i>
House Sparrow	<i>Passer domesticus</i>

^a Based on Salt and Salt (1976).

Table 3.2 Mammals expected to occur in the project area.^a

Common Name	Latin Name
Masked Shrew	<i>Sorex cinereus</i>
Arctic Shrew	<i>Sorex arcticus</i>
Water Shrew	<i>Sorex palustris</i>
Pygmy Shrew	<i>Sorex hoyi</i>
Little Brown Bat	<i>Myotis lucifugus</i>
Eastern Long-eared Bat	<i>Myotis septentrionalis</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Big Brown Bat	<i>Eptesicus fuscus</i>
Hoary Bat	<i>Lasiurus cinereus</i>
Snowshoe Hare	<i>Lepus americanus</i>
Lease Chipmunk	<i>Eutamias minimus</i>
Woodchuck	<i>Marmota monax</i>
Richardson's Ground Squirrel	<i>Spermophilus richardsonii</i>
Red Squirrel	<i>Tamiasciurus hudsonicus</i>
Northern Flying Squirrel	<i>Glaucomys sabrinus</i>
Beaver	<i>Castor canadensis</i>
Deer Mouse	<i>Peromyscus maniculatus</i>
Red-backed Vole	<i>Clethrionomys gapperi</i>
Heather Vole	<i>Phenacomys intermedius</i>
Meadow Vole	<i>Microtus pennsylvanicus</i>
Muskrat	<i>Ondatra zibethicus</i>
Northern Bog Lemming	<i>Synaptomys borealis</i>
Meadow Jumping Mouse	<i>Zapus hudsonicus</i>
Porcupine	<i>Erethizon dorsatum</i>
Coyote	<i>Canis latrans</i>
Wolf	<i>Canis lupus</i>
Red Fox	<i>Vulpes vulpes</i>
Black Bear	<i>Ursus americanus</i>
Marten	<i>Martes americana</i>
Fisher	<i>Martes pennanti</i>
Ermine	<i>Mustela erminea</i>
Least Weasel	<i>Mustela nivalis</i>
Mink	<i>Mustela vison</i>
Striped Shunk	<i>Mephitis mephitis</i>
Badger	<i>Taxidea taxus</i>
River Otter	<i>Lutra canadensis</i>
Lynx	<i>Lynx canadensis</i>

Table 3.2 Continued

Common Name	Latin Name
Elk	<i>Cervus elaphus</i>
Mule Deer	<i>Odocoileus hemionus</i>
White-tailed Deer	<i>Odocoileus virginianus</i>
Moose	<i>Alces alces</i>

^a Based on Soper (1964).

Table 3.3 Amphibian and reptile species expected to occur in the project area.

Common Name	Latin Name
Wood Frog	<i>Rana sylvatica</i>
Leopard Frog	<i>Rana pipiens</i>
Boreal Chorus Frog	<i>Pseudacris triseriata</i>
Canadian Toad	<i>Bufo hemiophrys</i>
Garter Snake	<i>Thamophis sirtalis</i>

^a Based on Stebbins (1966).

criteria (Table 3.4). The highest ranking species of 8 of the 10 species groups were chosen as representative management indicator species (MIS) (Table 3.5). The other two species groups, colonial birds and amphibians, did not have species that ranked high enough to be considered as indicators. The habitat requirements of each of the MIS selected are discussed below.

Dabbling Ducks

The mill site is situated in an area of moderate dabbling duck densities, and the duck harvest in the area is also rated as moderate (Nietfeld et al. 1985). It is not considered to be an area of priority waterfowl production. The nearest lake to the mill that is rated by the Alberta Fish and Wildlife Division's "Wildlife Key Area Maps" (AENR 1985) is 14 km distant. On a regional basis, Flat Lake provides the most important waterfowl habitat. The only closer waterbody with significance for waterfowl is the small lake and associated marsh immediately west of the proposed mill site. This lake currently has an area of approximately 70 ha or somewhat less, depending on the water level. Ducks Unlimited (Camrose) is planning to construct a dam on the outlet stream during 1989 in order to increase the lake area to 123 ha and to stabilize the water level.

Water is essential to dabbling duck habitat. The most suitable nesting habitat occurs in emergent vegetation such as sedges or bulrushes, where there is good nest cover. Hayfields, grain fields and pastures also serve as nesting sites. Dabbling ducks prefer potholes and open water marshes as nesting sites. These features are not common within the vicinity of the mill.

Spring and early summer are the most important periods in the annual life cycle of dabbling ducks as nesting and brood-rearing occurs during this time. Fall is also of importance as birds must accumulate fat reserves for their southward migration.

Table 3.4 Importance values assigned to species occurring within the project area.

Species Group	Species	Political Importance	Economic Commercial	Importance Subsistence	Recreational Consumptive	Importance Non-Consumptive	Ecological Factors Importance Vulnerability	Total Score
<u>Waterfowl</u>								
<u>Colonial Birds</u>	Canada Goose	1	1	2	3	1	2	11
	Dabbling Ducks	1	1	2	3	2	2	12
	Diving Ducks	1	1	2	2	2	1	11
	Grebes	0	0	0	0	2	1	5
<u>Colonial Birds</u>	Loons	0	0	0	0	3	1	6
							2	
<u>Raptors</u>	Gulls	0	0	0	0	1	1	3
<u>Upland Game Birds</u>	Bald Eagle	1	0	0	0	3	2	8
	Osprey	1	0	0	0	3	2	8
	Hawks	0	0	0	0	2	2	6
	Great Grey Owl	2	0	0	0	3	2	9
<u>Passerines</u>	Spruce Grouse	1	0	1	2	2	2	9
	Ruffed Grouse	1	0	2	3	2	1	11
	Sharp-tailed Grouse	1	0	2	3	2	1	11
<u>Small Mammals</u>	Loggerhead Shrikeb	2	0	0	0	3	1	8
	Others	0	0	0	0	3	1	6
<u>Small Mammals</u>	Shrews	0	0	0	0	1	1	3
	Voies	0	0	0	0	1	1	5
	Snowshoe Hare	0	0	2	1	2	3	9

Table 3.4 Continued

Series Group	Species	Political Importance	Economic Importance		Recreational Importance		Ecological Factors		Total Score
			Commercial	Subsistence	Consumptive	Non-Consumptive	Importance	Vulnerability	
<u>Terrestrial Furbearers</u>									
	Red Squirrel	0	2	0	0	1	2	1	6
	Coyote	0	1	0	0	1	2	1	5
	Wolf	0	1	0	0	2	2	1	6
	Black Bear	0	1	0	2	2	2	1	8
	Marten	1	3	0	0	2	2	1	9
	Fisher	1	3	0	0	2	2	2	10
	Weasels	1	2	0	0	2	2	1	8
	Lynx	1	3	1	0	2	2	2	11
<u>Aquatic Furbearers</u>									
	Beaver	1	3	1	0	3	2	1	11
	Muskrat	1	2	1	0	2	2	1	9
	Mink	1	3	0	0	2	2	1	9
	Otter	1	3	0	0	2	2	2	10
<u>Ungulates</u>									
	Deer	1	2	2	3	3	3	1	15
	Moose	1	2	3	3	3	3	1	16
<u>Amphibians</u>									
	Wood Frog	0	0	0	0	1	1	1	3
	Toad	0	0	0	0	1	1	1	3

^a Designated as rare by World Wildlife Fund (1987).^b Designated as threatened by World Wildlife Fund (1987).

Table 3.5 Management indicator species within the project area.

Species Group	Species
Waterfowl	Dabbling Ducks
Raptors	Great Grey Owl
Upland Game Birds	Ruffed Grouse
Passerines	Loggerhead Shrike
Small Mammals	Snowshoe Hare
Terrestrial Furbearers	Lynx
Aquatic Furbearers	Beaver
Ungulates	Moose

Great Grey Owl

The status of the great grey owl population in the study area is unknown. World Wildlife Fund (1987) lists the species as rare, while Alberta Fish and Wildlife does not list this species as either rare or vulnerable (Culbert 1987).

Great grey owls prefer mature coniferous forests and black spruce bogs. They also hunt in deciduous stands and open areas such as the fringes of agricultural fields.

Ruffed Grouse

Ruffed grouse are primarily dependent upon deciduous and mixedwood stands (Hay and O'Leary 1988). They prefer young aspen communities that have a dense shrub component. Older aspen forests are of moderate importance to ruffed grouse, while coniferous forests and black spruce bogs are of low importance. Cleared agricultural lands and open water bodies are not capable of supporting ruffed grouse populations.

Loggerhead Shrike

Loggerhead shrikes are not considered to be vulnerable or endangered by Alberta Fish and Wildlife (Culbert 1987), although World Wildlife Fund (1987) lists them as threatened in a national context. Their status within the vicinity of the proposed mill is not known.

Loggerhead shrikes occupy open areas, such as agricultural lands, and prefer fields with hedgerows and shrubby edges. They are not a forest dwelling species.

Snowshoe Hare

Snowshoe hares exhibit population cycles of approximately 10 years duration that are probably due to hare-food and hare-predator interactions (Brand et al. 1976, Keith et al. 1984). The current population levels in the study area are unknown.

Snowshoe hares prefer young forests with abundant understory that provide food and cover (Carreker 1985). Mixedwood and riparian habitats are best, with deciduous and bog vegetation types also ranking highly. Mature coniferous forests are not as preferred by hares, and cultivated fields are inadequate as habitat.

Lynx

Yearly fur harvest statistics for 11 Registered Trapping Areas closest to the mill site indicate that from 0 - 26 lynx were trapped annually between 1980 and 1988. This wide range is indicative of a species whose numbers fluctuate in response to changing snowshoe hare densities (Brand et al. 1976). A restricted trapping quota was established by the government in the early 1980's in response to overtrapping. This is also partly responsible for the large fluctuations in the lynx harvest.

As hares are the main prey item of lynx, they frequent the same vegetation types. Lynx prefer aspen communities with dense understory vegetation suitable for hare browse, as well as mixedwood stands with dense coniferous regeneration that provides hiding cover for hares (Hay and O'Leary 1988). They also utilize open conifer and black spruce bog habitat types (Parker 1980).

Beaver

The proposed mill is located in an area rated as prime for beaver in a provincial context (Nietfield et al. 1985), and 200 - 400 beavers are trapped per year in the 11 Registered Trapping Areas closest to the mill site. Beavers prefer high-density wetland and stream areas where deciduous vegetation is available for food and lodge construction. Mature coniferous stands provide poor habitat for beavers and agricultural lands are inadequate for their needs.

Moose

The study area is considered to be in the prime habitat zone for moose in Alberta by Nietfield et al. (1985), and Alberta Fish and Wildlife's "Wildlife Key Area Maps" indicate that the riparian zone adjacent to the Athabasca River is important for moose (AENR 1985). Surveys that have been done in similar areas suggest that moose densities are not particularly high, however (Ripin 1988). No moose sign was observed during a field survey conducted on August 29, 1988.

Moose depend upon early successional woody vegetation for food and therefore prefer areas disturbed by fire, logging, clearing and flooding (Franzmann 1981). Important winter habitats include riparian communities for foraging (Brusnyk and Gilbert 1983) and upland coniferous forests where less snow accumulates on the ground. During summer, moose feed upon aquatic vegetation as well as woody browse.

3.1.3 Habitat Importance

The suitability of each major habitat type in the project area was assessed for each management indicator species on a scale of 0 (inadequate) to 3 (best) (Table 3.6). The cumulative scores provide a measure of the overall importance of each habitat type. The riverine

Table 3.6 Cumulative suitability scores by Management Indicator Species and vegetation type.

Vegetation Type	Management Indicator Species								Cumulative Suitability Score
	Dabbling Ducks	Great Grey Owl	Ruffed Grouse	Loggerhead Shrike	Snowshoe Hare	Lynx	Beaver	Moose	
Aspen	0	2	3	0	2	2	3	2	14
Jackpine	0	3	2	0	1	1	1	1	9
Mixedwood	0	2	3	0	3	3	2	3	16
Balsam poplar	0	2	3	0	3	3	3	3	17
Tamarack-black spruce	0	3	2	0	2	2	1	1	11
Shrub	0	1	2	0	2	2	3	3	13
White spruce	0	3	1	0	1	1	1	1	8
Cultivated land	1	1	1	3	0	0	0	0	6
Water bodies	3	0	0	0	0	0	3	2	8

^a Ranked on a scale of 3 to 0; Best = 3, Moderate = 2, Poor = 1, Inadequate = 0.

balsam poplar unit was ranked as the most important habitat type overall, followed closely by the mixedwood forest type. The aspen and shrub habitat types also are quite important overall. The jackpine and tamarack-black spruce types are of intermediate importance overall, while the white spruce type and water bodies are of lesser importance. Cultivated land has the least importance overall as wildlife habitat.

3.2 IMPACTS

3.2.1 Management Indicator Species

Dabbling Ducks

No waterfowl habitat is expected to be lost to the mill and its infrastructure. Increased noise levels resulting from mill operations and truck traffic will be experienced at the small lake near the millsite on the west side. The effects of increased noise are mitigated by the fact that traffic to the mill past the lake will follow the route of an existing road that already carries some truck traffic. Waterfowl are well known to acclimatize readily to traffic noise and commonly frequent waterbodies adjacent even to such busy thoroughfares as the Trans Canada Highway. In the few formal studies of noise disturbance of waterfowl that have been done, traffic noise was not identified as a cause of disturbance (Gunn and Livingston 1974, Sharp 1978, U.S. EPA 1971). The available information therefore suggests that waterfowl at the small lake west of the mill site will not be negatively affected by project-related noise.

Great Grey Owl

Small areas of vegetation types favoured by the great grey owl (black spruce bog) may be lost to the proposed mill and to access corridor construction. Given the regional abundance of suitable habitat, impacts are expected to be minor.

Ruffed Grouse

The amount of ruffed grouse habitat that will be disturbed by the proposed project is minuscule compared to the total amount available in the general area. No impacts on ruffed grouse populations are therefore expected to occur.

Loggerhead Shrike

Construction of the mill will cause the loss of some agricultural lands, which are favoured habitat for loggerhead shrikes. This loss is so small compared to the total amount of such habitat available regionally that impacts can be considered to be negligible.

Snowshoe Hare, Lynx

The habitats favoured by these animals will be virtually unaffected by the proposed project, particularly in light of the total amount of such habitat available in the region. Impacts will be minor.

Beaver

Beavers are sensitive to development activities that would change water flows, water levels or shoreline vegetation. As construction of the proposed mill is not expected to modify these factors, no impact on beavers is expected.

Moose

Habitat loss for moose resulting from the proposed development will be negligible. Hunter access south of the river is already good and will not be materially affected by the project, so project-related increased hunting pressure in this area should be minor, if it occurs at all.

Summary

The wildlife species listed above represent the ecological requirements of most species present in the study area. Since the planned development does not materially reduce important habitat of any of these indicator species, it is assumed that the existing faunal assemblage will remain essentially unaltered.

3.2.2 Habitat

The mill site comprises 518 ha of land, approximately 60% of which will be cleared. Off-site facilities will require another 46 ha of clearing. Most of the clearing will affect agricultural land, the least important habitat type, although there will also be minor losses of the black spruce/tamarack bog, shrubland, aspen and mixedwood types (Table 3.7).

Table 3.7 Habitat types affected by the mill

	Area Cleared (ha)				
	Agricultural	Bog	Shrub	Mixed	Aspen
Within mill site	205	40	30	20	15
Water intake facilities	6	3	-	8	6
Effluent pipeline and outfall	16	-	-	7	0
Total	227	43	30	35	21

None of the on-site or off-site habitat losses are considered to be significant in either a local or regional context.

3.3 PROBLEM BEAR MANAGEMENT

The close proximity of the planned mill site to the Pine Sands Natural Area will likely result in a considerable increase in visitation, especially to the Poacher's Landing recreation site. Our field reconnaissance indicated the presence of at least three black bears in the Natural Area. Habitat quality is high for black bears along the North Saskatchewan River, and the sandy aprons along the river's edge provide ideal travel corridors. Increased visitation at the recreation site could result in heightened opportunities for bear-human conflicts, especially if strict garbage control is not maintained. We recommend two measures that will minimize potential problem bear incidents:

- provide a pamphlet to mill site employees and other users of the natural area outlining safety measures to be taken in "bear country";
- install bear-proof garbage containers at the Poacher's Landing recreation site.

4.0 LAND USE

4.1 EXISTING LAND USE

Current land uses within the project area (Figure 4.1) include agriculture, oil and gas, outdoor recreation, trapping, and hunting. There is also a sawmill at Spruce Valley, southeast of the proposed mill site, and a formally designated natural area, the Pine Sands Natural Area, along the Athabasca River to the north and northwest of the mill site. All land dispositions within the Natural Area require approval from the Minister of Forestry, Lands and Wildlife.

Agriculture

A substantial proportion of the land in the project area has been cleared for agriculture, including most of the proposed mill site. Cleared land is used primarily for the production of forage and cereal crops, and to a lesser extent for pasturage and residential purposes. The majority of farms are mixed. Some expansion of agricultural use is occurring, as evidenced by recent clearing in several areas.

Oil and Gas

There are a few active and completed potential natural gas wells in the project area, including one within the boundaries of the proposed mill site. In addition, a gas pipeline operated by Nova bisects the project area and mill site.

Outdoor Recreation

Recreational uses in the project area are centered on the Athabasca River and the Pine Sands Natural Area, particularly a recreation site called Poacher's Landing that has been developed near the east end of



NORTH

LEGEND

-  CLEARED AGRICULTURAL LAND
-  PIPELINE
-  EXISTING ROADS
-  GAS WELL (A) OR POTENTIAL GAS WELL (P)
-  DRAINAGE, WATERCOURSES
-  PROPOSED DAM
-  FARMSTEADS
-  ABANDONED FARMSTEADS

SCALE

0 500 1000 2000m

Appendix 3

Figure 4.1

LAND USE

the natural area. The recreation site includes a playground, picnic shelter and boat launch ramp. A network of cutlines and trails in the eastern portion of the natural area and adjacent uncleared land to the east is used by trail motorcyclists in summer and snowmobilers in winter.

Sport fishing opportunities within the project area are limited to the Athabasca River, which provides good fishing for walleye and pike during periods when the water is clear.

Trapping

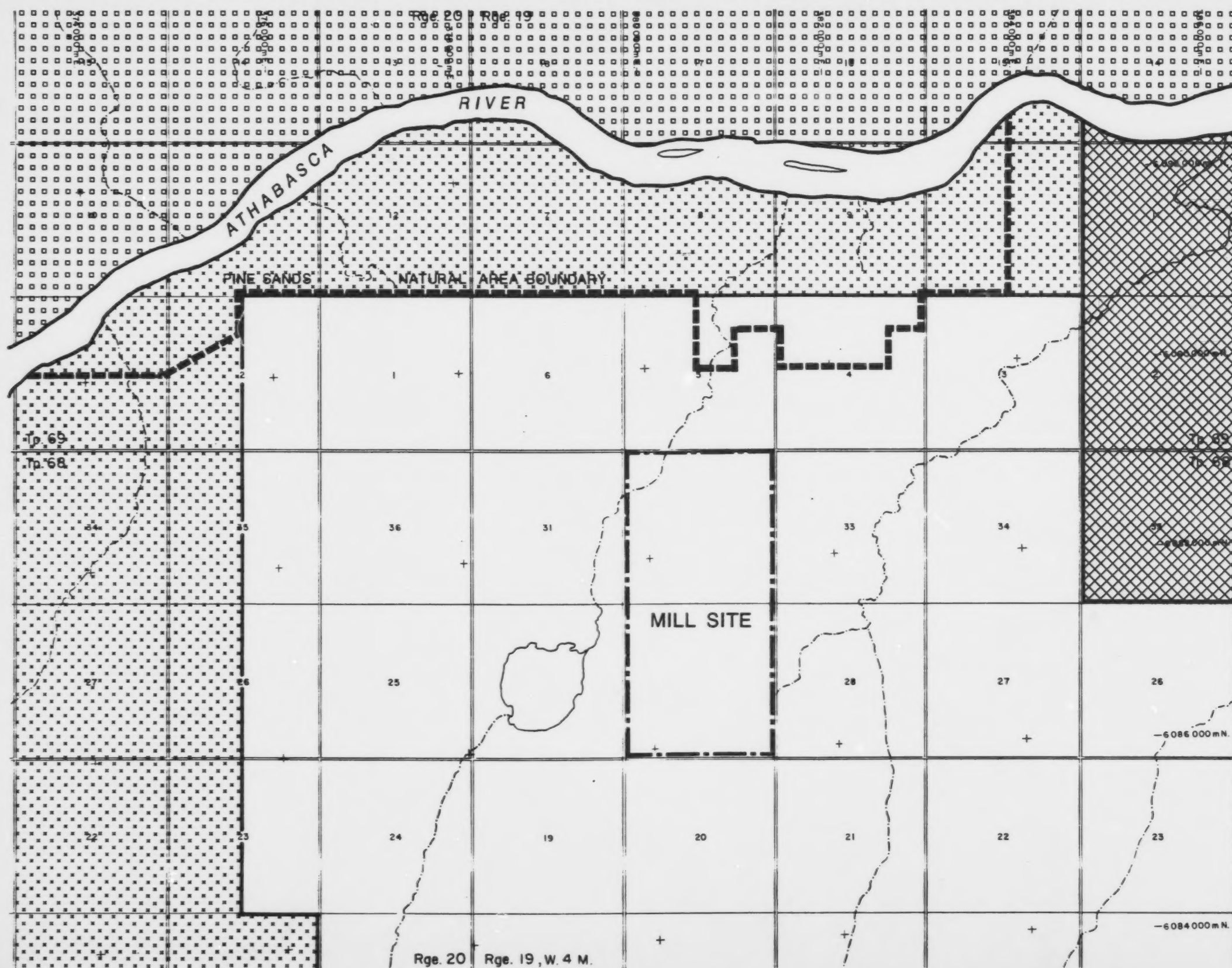
Although the mill site itself does not lie within a Registered Trapping Area (RTA), there are two RTA's located only a short distance away (Figure 4.2, Table 4.1).

Table 4.1 Active trappers potentially affected by the mill site.

RTA	Trapper	Address	Primary Species Trapped	Revenue ^a
1836	Kamelchuk, Mike	R.R. 1, Site 3 Boyle TOA OMO	Coyote, beaver, fisher	\$2,886
1907	Onischuk, John Jr.	Box 91, Grassland TOA 1V0	Beaver, coyote, squirrel	\$1,702

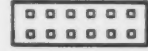
^a estimated average annual revenue, 1980 - 1987

Beaver and coyote are the staple fur species of almost all trappers in the vicinity of the project area. Other important species are red squirrel, fisher, muskrat and mink. Lynx provided considerable revenue to certain trappers in the early 1980's, but have become considerably less important since a reduced government quota was set in 1983.



NORTH ↑

LEGEND

-  TRAPPING AREA 1831
-  TRAPPING AREA 1836
-  TRAPPING AREA 1907
-  UNASSIGNED AREA

SCALE

0 500 1000 2000m

Appendix 3

Figure 4.2

REGISTERED TRAPPING AREAS



There are no fur harvest statistics available for open areas (private lands) within the project area. In Alberta, an individual may purchase a resident trapper's license which allows him to trap on private lands, providing that permission is obtained from the landowner. Given that most of the open trapping area in the vicinity of the planned project is cultivated and bog, it is unlikely that private trapping levels are significant.

Hunting

The project area lies within Alberta Wildlife Management Unit (WMU) 509 but comprises only a small fraction of it. Hunting statistics for WMU 509 for 1985 to 1987 (Table 4.2) indicate that white-tailed deer is the most important species hunted, both in terms of total hunter days and number of animals harvested. Moose is the second most hunted and harvested species. A significant number of hunter days also go toward mule deer, although comparatively few animals are harvested. Other animals are not normally hunted within the WMU, although there was a limited fall black bear season in 1986.

Table 4.2 Hunting statistics for WMU 509.

Species	Total Hunter Days			Animals Harvested		
	1985	1986	1987	1985	1986	1987
Moose	1590	2935	2406	70	170	101
Mule Deer	918	1080	1166	9	18	22
White-tailed Deer	3494	4047	3792	303	347	234
Black Bear	-	22	-	-	11	-

4.2 IMPACTS

Agriculture

The amounts of agricultural land affected by the pulp mill are shown below.

A - cleared for facility construction:

- | | |
|-------------------------|--------|
| • within the mill site | 205 ha |
| • outside the mill site | 22 ha |

B - within the mill site, but not used 130 ha

C - within the buffer zone 550 ha

The lands in Category A will be lost to agricultural production for the duration of the project as they will be occupied by facilities. These lands are rated under the Canada Land Inventory system as having a Class 4 capability for agriculture (severe limitations to agriculture), with the exception of 16 ha along the route of the effluent pipeline, which has a Class 3 capability (moderately severe limitations to agriculture). Alberta-Pacific may wish to use some of the agricultural land in the buffer zone (Category C) for forestry research but intends to lease the remainder to neighbouring farmers; the Company will also consider leasing unused portions of the mill site for agricultural use. The agricultural lands within Categories B and C are virtually all Class 4.

Construction of the mill site, and to a lesser extent, the rail line, may cause some disruption of nearby agricultural operations. Where existing fields are split by the rail line, continuing inconvenience in terms of severance may occur. Some changes to existing road patterns will occur in the vicinity of the mill, but a development agreement to be negotiated between Crestbrook and the County of Athabasca will ensure that the local transportation network remains functionally unaltered.

Maximum ground level concentrations of gaseous emissions from the mill will be well below the standards set by Alberta Environment and will not affect crop yields (Appendix 2). Agricultural soils will not be significantly affected by sulphur deposition from the mill, which will be only 7.5% of current levels in the zone of maximum deposition (Appendix 2).

Oil and Gas

Hydrocarbon exploration and development will be largely unaffected by the project. The mill layout has been planned around the existing gas well on the proposed mill site; however, a short (approximately 3 km) section of the existing Nova pipeline will have to be relocated about 500 m to the west.

Forest Products

Existing forest product operations will be benefited by the project, as Alberta-Pacific will purchase wood chips from local operators, providing new product and revenue opportunities.

Outdoor Recreation

Outdoor recreation opportunities will not be materially affected by the proposed mill, although it will be felt by some that the mill is an intrusion on the natural area in terms of visual impact and possibly odour. The demand for recreation opportunities in the area will increase, and it can be expected that the Poacher's Landing Recreational Area will receive higher use. The Pine Sands Natural Area will not otherwise be directly affected by the proposed mill except along the alignment of the raw water pipeline and associated service road, which will parallel the existing Nova gas pipeline corridor. Accessibility to the Natural Area will be little altered by this

development as a 4 wheel drive access road (passable to within a kilometre of the Athabasca River by passenger vehicles) already runs the length of the Nova right-of-way.

It is possible that river-based recreation will occasionally be affected in the immediate vicinity of the effluent discharge in terms of aesthetics (colour, odour, foam).

Trapping

The mill site is not located within a Registered Trapping Area (RTA). The current vegetation on the mill site area is largely cropland and muskeg, and it is unlikely that trappers have been active in the area under open area private trapping permits. Hence, direct habitat loss from mill site construction will not materially affect trapping. The water intake facility will follow the existing Nova gas pipeline right-of-way that passes through RTA #1836 for approximately 1.5 km. Development of this facility will involve minor habitat loss but this is not expected to impact trapping success. The planned effluent corridor will pass through about 2.5 km of the northwest corner of RTA #1907. Some limited loss of habitat will be incurred, although the right-of-way may also provide convenient access for trapping activities. The overall impact of the effluent corridor on trapping success on RTA #1907 is expected to be minimal.

Hunting

Hunting activity in the vicinity of the mill site is already likely to be limited, due to hunting restrictions within the adjacent natural area and the relatively high occurrence of private lands and associated residences. Furthermore, the mill and its facilities will not cause the loss of important big game, upland game or waterfowl habitat. Hence, the pulp mill is not expected to affect local hunting.

Natural Area

The impacts of mill construction and operations on the Pine Sands Natural Area will include:

- vegetation clearing along the western edge of the existing NOVA gas pipeline right-of-way to accommodate construction of the water supply and warm water return pipelines;
- construction of a water intake and pumphouse on the Athabasca River near the NOVA pipeline crossing;
- construction of an access road along the new pipeline corridor;
- construction of a new highway through the western tip of the natural area by Alberta Transportation; and
- potential increased use of the Poacher's Landing recreation site.

Terrain and vegetation impacts along the new pipeline right-of-way will be mitigated by minimizing the width of clearing and utilizing the NOVA right-of-way for construction room to the maximum extent possible, and by prompt revegetation of disturbed areas with appropriate species to prevent erosion. The impacts of the new highway will be addressed by Alberta Transportation. Construction workers will be discouraged from using the Poacher's Landing recreation site in order to avoid conflicts with local residents.

Habitat losses within the natural area will be too small to materially affect wildlife. Vegetation will not be affected by atmospheric emissions from the mill.

5.0 HISTORICAL RESOURCES

5.1 EXISTING HISTORICAL RESOURCES

A historical resources impact assessment comprising a surface reconnaissance and subsurface testing was carried out for the Alberta-Pacific project in the areas that will be occupied by the following facilities:

- the pulp mill and effluent treatment system,
- the raw water supply pipeline,
- the treated effluent pipeline,
- the water intake and pumphouse facilities,
- the foam control pond and outfall/diffuser facilities,
- access roads to the water intake and effluent outfall areas,
- the pulp mill access road, and
- the rail spur right-of-way from Boyle to the pulp mill site.

There are no known historical resources in these areas and no historical resources were encountered during the field investigations.

5.2 IMPACTS

No historical resource impacts are anticipated in the areas examined during the field investigations. Should any revision to the planned location of mill facilities and infrastructure occur, the potential for the alterations to affect historical resources will be evaluated.

Concern has been expressed that the Lac La Biche Mission site at Lac La Biche may be adversely affected by pulp mill atmospheric emissions. Sulphur deposition modelling carried out for the environmental impact assessment (Appendix 2) indicates that the maximum expected increase in sulphur deposition at the Mission site will be 0.1 kg/ha/yr, which is about 0.3% of existing rates; thus no measurable effect on the Mission site from this source is anticipated.

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1.0 INTRODUCTION

This working paper investigates the socio-economic effects of Alberta-Pacific Forest Industry's (APFI's) proposed 1500 ADMT Bleached Kraft Mill upon northeast Alberta. Two other studies have been relied upon for background data and are referred to throughout. They are:

1. Crestbrook Forest Industries
Proposed Alberta Project
Economic Impact Study
Price Waterhouse Management Consultants
August 1988
2. Crestbrook Forest Industries
Forest Development Program for Northeast Alberta
Mill Site Selection Study
Stanley Associates Engineering Ltd.
August 1988

The second of these studies appears as Appendix 5 of this report.

The proposed pulp mill site is located 36 km north of the Village of Boyle in the County of Athabasca. The communities of Athabasca and Plamondon are both about 47 km from the site and Lac La Biche is about 20 km further. All four communities are within daily commuting distance of the mill site (i.e. under 45 minutes - one way).

Approximately 27,000 person-months of labour will be required to construct the mill over 3 years. The on-site labour force will likely peak at 2,600 people, with on-site accommodation for 1,400 to 1,900 people being provided in a construction camp. Infrastructure required to service the mill during operations includes water from the Athabasca River, one train per day of outbound air dried pulp, a 138 kV power line, and a natural gas supply line. Waste products include liquid effluents, air emissions, and solid wastes. A mill site of 400 hectares is required along with a suitable buffer zone surrounding the mill fence.

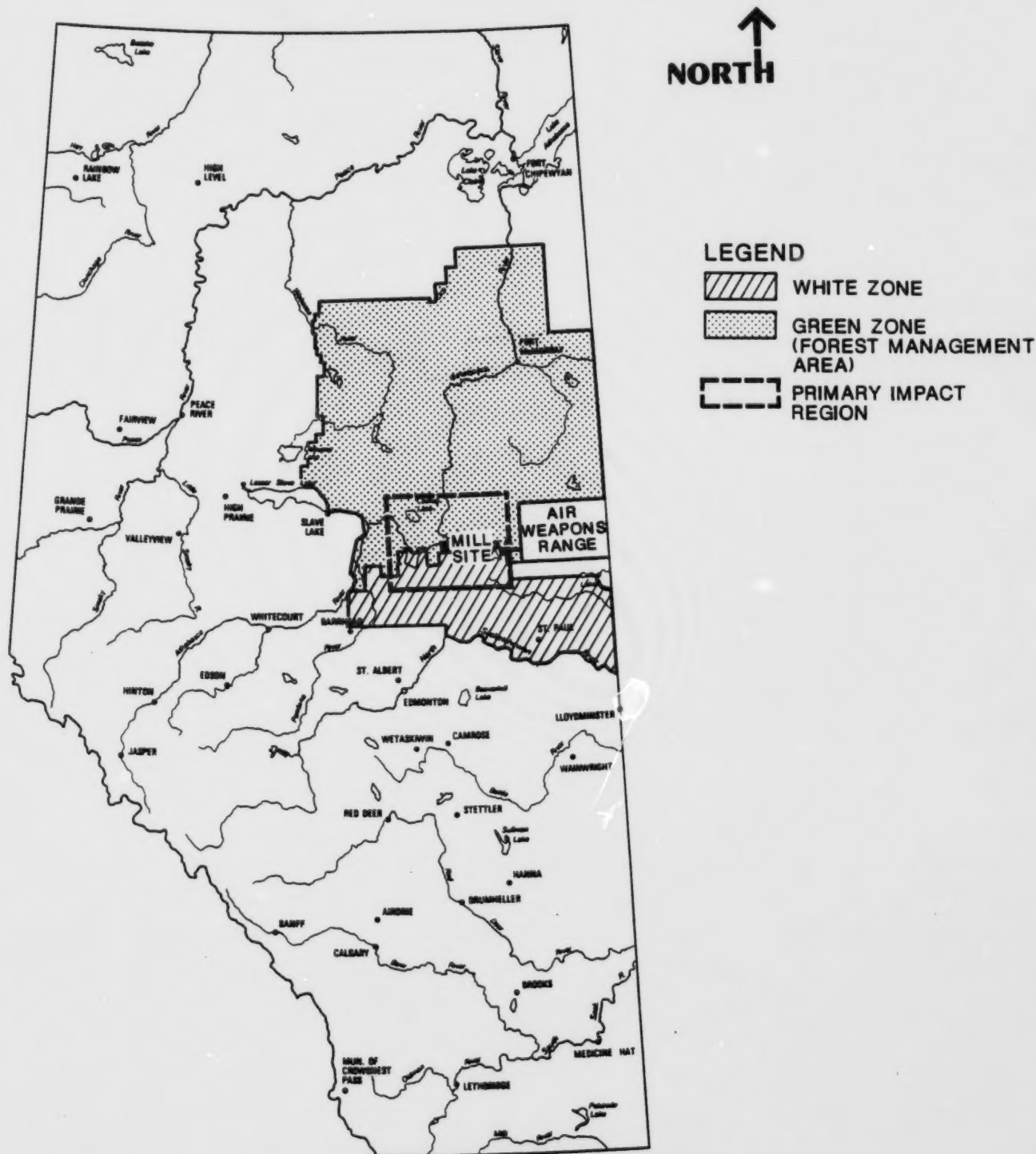
2.0 PROJECT REGION

2.1 BACKGROUND

The project region (Figure 1) includes two major wood supply areas: the Green Zone and the White Zone. The wood required for the mill is 2.4 million cubic metres per year. The supply of wood will be composed of about 76% aspen and 24% softwoods. Approximately 95% of the wood will come from the Green Zone with the remainder (5%) designated to come from private wood lots in the White Zone.

The pulp mill primary impact region is shown in Figure 2. This region includes the County of Athabasca and portions of Improvement Districts 17 and 18. Located within this broadly defined region are the urban communities of Athabasca, Boyle, Lac La Biche and Plamondon. Other communities in the region include the Indian Reserves of Calling Lake (part of the Bigstone Cree Band), Beaver Lake, and Heart Lake. Numerous Metis locals exist in the primary impact region in communities such as Lac La Biche and Calling Lake. The Metis Settlement of Beaver River (Kikino) is located just east of Boyle and covers an extensive forested area.

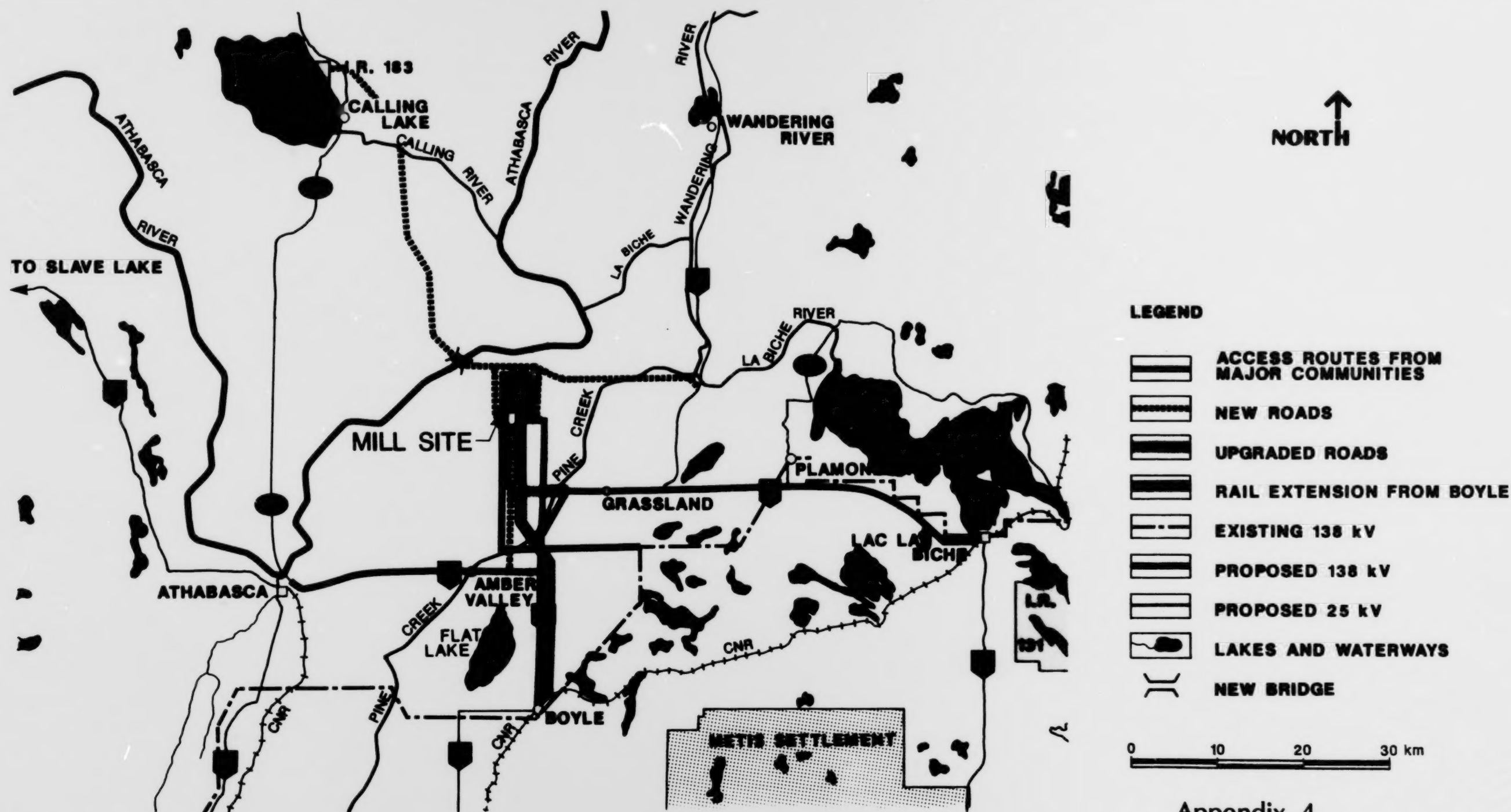
The primary impact region is located about 160 km northeast of Edmonton and contains substantial water resources. The Athabasca River flows south from the western boundary of the region to the Town of Athabasca, where it resumes its northward journey to Lake Athabasca and the Arctic Ocean via Great Slave Lake and the Mackenzie River. Numerous lakes are located within the region. Several small lakes are located in the forested areas west of the Town of Athabasca. Calling Lake, north of the Town of Athabasca, is the second largest lake in the region. The largest lake in the region is Lac La Biche, upon which is located the town which takes its name from the lake. Numerous lakes abound from Boyle to the eastern boundary of the region and form the western edge



Appendix 4

Figure 1

PROJECT REGION



Appendix 4

Figure 2

MILL SITE PRIMARY
IMPACT REGION

of the Lakeland District, which extends from Boyle to the Saskatchewan border.

Other local streams include Pine Creek, Wandering River and Lac La Biche River.

Transportation infrastructure in the region includes four major Provincial Highways - #2, #63, #55, and #36. Secondary Road 813 links the Town of Athabasca to Calling Lake. This highway is presently being extended northwest from Calling Lake to Wabasca/Desmarais. Rail service is provided by the CNR to the region through two rail lines. The rail line to Athabasca is used primarily to transport grain from the railhead. The major industrial line is the former Northern Alberta Railway Line from Edmonton to Fort McMurray. This line presently carries sulphur trains from the oil sand plants and grain and lumber from Lac La Biche and Boyle. This line is undergoing continuous upgrading and will continue to be the major industrial rail line serving the region now and in the future.

2.2 POPULATION AND LABOUR FORCE

The number of people who live in the Project Region is given in Table 1. Both major towns are growing, whereas the two villages and the County of Athabasca are remaining relatively stable. The proportion of the population employed in the labour force (41%) is below the provincial average of 54% and reflects the resource nature of the economy, which is still male dominated. However, Lac La Biche and the Town of Athabasca are close to the provincial average, reflecting the service sector employment associated with government, quasi-government, and educational institutions located in both communities.

TABLE 1
POPULATION AND LABOUR FORCE
PROJECT REGION
1981/1986

AREA	1981		1986	
	PopN	Labour Force	PopN	Labour Force (est'd)
Towns				
Athabasca	1,731	790	1,970	898
Lac La Biche	2,007	1,000	2,553	1,271
Villages				
Boyle	638	230	678	244
Plamondon	259	105	236	96
Counties				
County of Athabasca (#12)	5,974	2,830	5,979	2,834
Improvement Districts				
ID #17	11,699	4,655	12,534	4,989
ID #18	9,605	3,435	10,495	<u>3,758</u>
TOTAL REGION	31,913	13,045	34,445	14,090

Source: Price Waterhouse, Statistics Canada

The population and labour force data for ID #17 and ID #18 are for the southern portions only. These southern portions cover a broad rural area. ID #17 south extends west from the Athabasca River to the Peace River and includes rural areas south of Lesser Slave Lake. ID #18 south extends east from the Athabasca River to the Saskatchewan Boundary. A reasonable estimate of population in the Primary Impact Region is about 15,000 with an employed labour force of 7,200 people.

Based upon 15,000 people, an age-sex breakdown is estimated as follows:

Age	Population 1986	Region %	Alberta %
0 - 4	1,350	9.0	8.6
5 - 14	2,460	16.4	15.0
15 - 19	1,290	8.6	7.7
20 - 24	1,215	8.1	9.6
25 - 44	4,035	26.9	34.4
45 - 64	2,850	19.0	16.6
65+	<u>1,800</u>	<u>12.0</u>	<u>8.1</u>
	15,000	100.0	100.0

Male/ Female 53/47

Source: 1986 Statistics Canada

These data show that there are slightly higher numbers of children and young adults living in the Primary Impact Region as compared with Provincial averages. The most notable differences between the Region and the province as a whole occur in the 20-44/45-65+ age groupings. There is a significant difference in the proportion of population in the 20-44 age group with only 35% of the Region's population falling in this primary child-bearing age range compared to the provincial average of 40%. The reverse is true in the over 45 age groups (31% for the

Region vs. 25% for Alberta). This suggests that the Primary Impact Region contains a potentially unstable socio-economic environment which has the following characteristics:

- an aging population
- a deficiency of people of child-bearing age
- larger than average family sizes.

This creates a situation in which, without new regional employment opportunities, young adults migrate out of the region in search of employment opportunities elsewhere. As the over 45 population grows older and retires, the region could eventually lose this wisdom from its workforce. Currently, there is a dearth of local people to choose from in the under 45 age group to replace people now in the 45-64 age group.

2.3 ECONOMIC BASE

Local employment statistics indicate that the economic base of the Primary Impact Region consists of agriculture, gas and oil, forestry, fishing, post-secondary education, public administration and tourism.

2.4 HOUSING

Housing in the Primary Impact Region is available in the urban communities of Athabasca, Lac La Biche and Boyle. Country residential development on non-farm properties is extensive around Lac La Biche (the lake) and Skeleton Lake east of Boyle.

2.5 EDUCATION

2.5.1 Primary/Secondary

The primary and secondary school systems are operated by the County of Athabasca and the Lac La Biche School Division. 1987/88 enrolments, school capacities, and utilization are given in Table 2 for each school in the region. This table shows that the urban schools are generally well utilized and that the rural ones are severely underutilized at less than 50%. Over the total region, school enrolment in 1987/88 amounted to 3,940 students for a 67.9% utilization.

2.5.2 Post Secondary

The Region is relatively well endowed with post-secondary institutions in the form of Athabasca University and the Adult Vocational Centre in Lac La Biche.

Athabasca University has a 194 ha campus in Athabasca, but its programs are mostly based on home study. Enrolment in 1987 was 10,772. Athabasca University offers undergraduate degree programs in administration, arts and general studies, as well as university certificate programs in administration and public administration.

The Alberta Vocational Centre (AVC) at Lac La Biche is a comprehensive educational institution geared to the maturing student. The centre is located on an 11 ha site and has 35 classrooms and 5 apprenticeship trade shops. The AVC campus offers courses in business careers, human services, trades, technical programs, and academic upgrading. Courses already offered that are of relevance to the pulp mill and forestry operation include "forestry crew worker," "power engineering," "carpentry", "welding", "motor mechanics", "accounting", "administration", "typing" and "word processing".

TABLE 2
ELEMENTARY/SECONDARY SCHOOLS
PRIMARY IMPACT REGION

County of Athabasca	Type	Capacity	Utilization	Number of School Children
Edwin Parr	Junior & Senior High	1,015	61.8%	
Athabasca	Elementary	730	77.8%	
Boyle School	Elementary, Junior & Senior High	415	57.4%	
Grassland	Elementary, Junior & Senior High	375	49.9%	
Rochester	Elementary & Junior High	250	38.4%	
Smith	Elementary & Junior High	<u>275</u>	<u>40.0%</u>	
		3,060	59.7%	1,830
Lac La Biche Area				
Central	Grades 5-6	200	118.0%	
Vera M. Welsh	Grade 1-4	665	84.9%	
Dr. Swift	Junior High	465	52.7%	
J.A. Williams High	Senior High	580	86.6%	
Plamondon	Grades K-12	375	97.0%	
Wandering River	Grades K-9	175	43.0%	
Cowslund	Grades K-6	<u>275</u>	<u>44.4%</u>	
		2,735	77.1%	<u>2,100</u>
	TOTAL	5,795	67.9%	3,940

Source: Price Waterhouse
Alberta Ministry of Education
Data are based on the 1987/88 school year

2.6 HOSPITALS

There are three hospitals in the region, as shown in Table 3, which between them account for a total of 144 beds. Utilization is high in Athabasca and Lac La Biche but low in Boyle.

TABLE 3
HOSPITAL CAPACITY (1)
IN THE PRIMARY IMPACT REGION

Location	Hospital Name	Number of Beds	% Utilization(3)
Town of Athabasca	Athabasca Hospital and Nursing Home (2)	92	90.6%
Lac La Biche	William J. Ladzow	72	75.2%
Boyle	Boyle Hospital	<u>30</u>	<u>41.0%</u>
	TOTAL	194	77.2%

Note: (1) Data are for the year ending March 31, 1986. 1987 and 1988 data are not yet available.

(2) Includes 42 beds at the hospital and 50 at the nursing home.

(3) Based on an estimated number of beds in Alberta of 12,985 for a population of 2,365,285 people.

Source: Price Waterhouse
Alberta Hospitals and Medical Care, Edmonton

2.7 RECREATION AND TOURISM

There are numerous recreational opportunities in the Athabasca/Lac La Biche Region in both the urban areas, as well as the rural areas. Recreational infrastructure in the urban areas is summarized in Table 4. Rural opportunities include hunting, fishing and boating on the numerous lakes and rivers in the area. Facility-oriented outdoor recreation opportunities are available at Calling Lake, Sir Winston Churchill and Long Lake provincial parks and at Pine Sands Natural Area. These opportunities for outdoor recreation create a lifestyle environment that is somewhat unique in the Province for both residents and visitors to the area.

TABLE 4
URBAN RECREATION FACILITIES

Facility	Athabasca	Lac La Biche	Boyle	Plamondon
Indoor Arena	X	X	X	X
Curling Rink	X	X	X	X
Golf Course	X	X	X	
Swimming Pool	X			
Outdoor Recreation	X	X	X	

The Primary Impact Region has considerable potential for increased tourism and is also presently a tourist destination; however, most of the tourist activity is related to the use of the region by local residents and other Albertans as a fishing, boating and swimming area.

There are currently a number of local initiatives being undertaken that will raise the profile of the area as a tourism destination point for visitors from outside Alberta. These include the \$1.3 million investment proposed for the Lac La Biche Mission and the proposed

Tawatinaw Trail Interpretive Center in the Town of Athabasca.

2.8 URBAN INFRASTRUCTURE

The urban communities within the Primary Impact Region are well serviced with water supply and sewage treatment systems. The population capacity of these systems is given in Table 5.

TABLE 5
URBAN INFRASTRUCTURE

Urban Community	Water System			Sewage System		
	Capacity	1986 Population	Surplus Capacity	Capacity	1986 Population	Surplus Capacity
Athabasca	4,500	1,970	2,530	4,500	1,970	2,530
Boyle	1,500	678	822	1,400	678	722
Lac La Biche	5,000	2,553	2,447	5,000	2,553	2,447
Plamondon	<u>500</u>	<u>236</u>	<u>264</u>	<u>1,000</u>	<u>236</u>	<u>764</u>
Total Region	11,500	5,437	6,063	11,900	5,437	6,463

Source: Personal Communication - Local Authorities



3.0 ECONOMIC AND COMMUNITY EFFECTS

The capital investment of some \$1.3 billion to construct a pulp mill and related infrastructure over a 3 year period will bring substantial socio-economic benefits to the region. Over 20 years of operation, it is estimated that an additional \$3.2 billion will be spent. Additional capital investment of a further \$300 million could also take place in response to favourable market conditions and industrial synergy (e.g. paper mill, chemical manufacturing, etc.).

3.1 EMPLOYMENT AND INCOME

3.1.1 Construction

During construction it is estimated that direct employment will amount to some 33,600 man-months over 3 years (1989-1991) with a gross payroll of some \$152 million. The majority of construction (80%) will be focussed upon the pulp mill itself, with the remainder being associated with the construction of a rail spur and roads outside the mill fence and housing in the communities. Table 6 summarizes mill construction employment by trade on a quarterly basis.

Using appropriate economic multipliers, it is estimated that the benefit to Alberta (including the region) will be 80,400 man-months and \$250 million and the benefit to Canada will be 114,000 man-months and \$320 million (Table 7).

TABLE 6
CONSTRUCTION FORCE
LABOUR REQUIREMENTS
(PERSON-MONTHS)

		Civil	Elec- tricians	Pipe- fitters	Welders	Boiler- makers	Mech- anical	Total
1989	Q3	345	-	-	-	30	-	375
	Q4	1380	-	-	-	120	-	1500
1990	Q1	150	230	190	190	120	120	1000
	Q2	380	590	485	485	305	305	2550
	Q3	790	1220	1010	1010	635	635	5300
	Q4	900	1380	1140	1140	720	720	6000
1991	Q1	700	1065	875	875	555	555	4625
	Q2	630	970	800	800	500	500	4200
	Q3	170	250	210	210	130	130	1100
	Q4	50	80	70	70	40	40	350
Total		5495	5785	4780	4780	3155	3005	27,000

TABLE 7
EMPLOYMENT AND INCOME IMPACTS
ARISING FROM CONSTRUCTION

	Multipliers	Man Months of Construction Employment	Gross Payroll (Millions)
Direct			
Pulp mill		27,000	\$124
Railway and Roads		5,400	23
Housing and other		<u>1,200</u>	<u>5</u>
	1.0	33,600	152
Regional Indirect and Induced	<u>0.15</u>	<u>5,040</u>	<u>10</u>
	1.15	38,640	162
Other parts of Alberta	<u>1.24</u>	<u>41,760</u>	<u>88</u>
	2.39	80,400	250
Other parts of Canada	<u>1.00</u>	<u>33,600</u>	<u>70</u>
	3.39	114,000	320

Source: Direct employment and payrolls based on APFI data and estimated by Price Waterhouse. Multipliers are estimated on the basis of data from the Alberta Bureau of Statistics and the Government of Canada.

3.1.2 Operations

It will require about 440 people to operate the pulp mill (Table 8) and 660 people (full time equivalent) to supply wood to the mill (logs & chips). Over 20 years of operation this would amount to a gross payroll of some \$990 million (Table 9). Total employment in the overall Project Region would amount to 1925 jobs and a gross payroll of \$1.3 billion. The corresponding figures for Alberta are estimated to be 2,750 jobs and \$1.6 billion; for Canada they are estimated to be 3,850 jobs and \$2.0 billion.

Spinoff industries and commercial/services required in the region will include:

- o warehousing and distribution
- o specialty maintenance shops for pulp mill, logging and road building equipment
- o auto and truck dealers
- o hotels/motels
- o services such as banking, finance, wholesale and retail
- o health, education and training
- o forestry consulting
- o transportation

TABLE 8
OPERATIONS EMPLOYMENT BY OCCUPATION

<u>Designation:</u>	<u>Number:</u>
Mill Manager/ Assistant Mill Manager	2
Human Resources (safety, training & relief pool)	39
Power and Recovery (steam plant)	28
Wood Handling	50
Machine Room	26
Pulping Group	29
Technical/Environment	3
Materials Handling & Traffic	8
Engineering/Maintenance (trades such as mill wright, welding pipefitting, instrument mechanics, machinists, carpenters, painters)	96
Process Engineering & Technicians	27
Engineers & Planners	12
Forestry	35
Accounting	10
Ongoing Capital Projects	<u>75</u>
TOTAL	440

* NOTE: includes 6 secretarial/clerical positions

TABLE 9

PERMANENT EMPLOYMENT FOR OPERATIONS

	Multiplier	Number of Permanent Jobs	Gross Payroll	
			Annual at Full Capacity	Cumulative 1991-2010
(Millions)				
Direct Employment				
Pulp mill		365	\$ 19	\$ 376
Wood supply		660	22	425
Capital projects		75	4	83
	<u>1.00</u>	<u>1,100</u>	<u>45</u>	<u>884</u>
Regional				
Indirect and				
Induced	<u>0.75</u>	<u>825</u>	<u>21</u>	<u>398</u>
	<u>1.75</u>	<u>1,925</u>	<u>66</u>	<u>1,282</u>
Other parts of Alberta				
Indirect and				
Induced	<u>0.75</u>	<u>825</u>	<u>20</u>	<u>395</u>
	<u>2.50</u>	<u>2,750</u>	<u>86</u>	<u>1,677</u>
Other parts of Canada				
Indirect and				
Induced	<u>1.00</u>	<u>1,100</u>	<u>28</u>	<u>531</u>
	<u>3.50</u>	<u>3,850</u>	<u>\$ 114</u>	<u>\$ 2,208</u>

Source: Direct employment and payroll cost based on APFI data. Multipliers are estimated on the basis of data from the Alberta Bureau of Statistics and the Government of Canada.

3.2 BUSINESS OPPORTUNITIES

There will be a number of business opportunities created in the region as a result of this project. Some of these opportunities are listed below:

CONSTRUCTION:

- Clearing and Grubbing
- Fencing
- Trucking
- Camp Set-up
- Catering
- Sand and Gravel Supply
- Training
- Housing
- Fuel Supply
- Hotel/Motel
- Food Beverage

OPERATION:

- Specialty Maintenance Shops
- Auto and Truck Dealers
- Warehousing/Distribution
- Trucking
- Forestry Consulting
- Security
- Logging
- Wood Chip Supply
- Logging Road Construction

Business seminars will be conducted by Alberta-Pacific throughout the project in the region to allow local businessmen to become familiar with the opportunities and to submit bids on contracts.

3.3 POPULATION GROWTH

The creation of 1,050 jobs within the region during operations (Table 10) will result in a permanent increase in the population of the immediate area within commuting distance of the mill. Population increase during construction in the communities will be minimized due to the location of a construction camp on the site.

The resulting population growth in the region expected as a result of direct, indirect, and induced employment during operations is presented in Table 11. Table 11 shows that the region is expected to grow by about 2,000 people by 1992.

3.4 HOUSING REQUIREMENTS

It is estimated that 665 new households will have to be constructed in the region to accommodate the population influx. This based upon 510 families requiring single family units and 155 singles requiring multiple units (townhouses, apartments, etc.) and assumes that only 75% of the incoming population requires new housing. The remainder would rent/purchase existing, vacant accommodation.

3.5 EDUCATION

An estimated 575 students would be added to the elementary/secondary school systems in the region. Of these between 60% and 75% would reside within the County of Athabasca School System and 25% - 40% within the Lac La Biche School System.

TABLE 10
PROJECTED INCREASE IN
LOCAL EMPLOYMENT FROM OPERATIONS

	Athabasca/ Lac La Biche Region	Northern Region Excluding Athabasca/ Lac La Biche Region	Total
Direct Employment	600	500	1,100
Indirect Employment	<u>450</u>	<u>375</u>	<u>825</u>
	1,050	875	1,925
Jobs filled by:			
Locals	285	235	520
Inmigrants	<u>765</u>	<u>640</u>	<u>1,405</u>
	1,050	875	1,925

Source: Price Waterhouse

TABLE 11
PROJECTED INCREASE IN POPULATION
DURING OPERATIONS

	Athabasca/ Lac La Biche Region	Northern Region Excluding Athabasca	Total
Children			
0 - 4	190	160	350
5 - 19	<u>575</u>	<u>480</u>	<u>1,055</u>
	765	640	1,405
Adults			
19 - 65	1,175	980	2,155
65+	<u>-</u>	<u>-</u>	<u>-</u>
TOTAL	1,940	1,620	3,560

Source: Price Waterhouse

Training programs will be initiated by Alberta-Pacific through ongoing discussions with both the Adult Vocational Centre in Lac La Biche and Athabasca University.

3.6 MEDICAL/SOCIAL SERVICES

The demands placed by an additional 2,000 people upon the medical and social services in the region are not expected to be significant. The 142 hospital beds in the region in 1986 are sufficient to accommodate a regional population of 28,400 people. A 2,000 person increase on top of the estimated region population of 15,000 will help to better utilize existing facilities.

3.7 RECREATION

It will necessary to increase recreation services in communities that experience growth as a result of the project.

3.8 TRANSPORTATION/UTILITIES

Regional transportation will be improved with the construction of a new highway bridge across the Athabasca River. This bridge and associated highway system improvements will provide a direct road link between the Wabasca/Calling Lake area and the Lac La Biche area.

The additional rail traffic on the CNR line at Boyle will increase the economic viability of the existing rail line between Edmonton and Fort McMurray.

A 138 kV tie line will be constructed from the existing line that connects Boyle to Lac La Biche. The tie line will be used to provide standby power purchased from TransAlta Utilities.



4.0 SOCIO-ECONOMIC IMPACTS

4.1 EMPLOYMENT AND INCOME

4.1.1 Construction

Construction employment in the primary impact region will average 930 man-years over 3 years. This represents an increase in employment of about 13% in the primary impact region.

4.1.2 Operations

Operations employment will amount to 1,050 people in the primary impact region. This represents an increase of 15% over and above 1988 employment levels, and a 1.5% increase over 1990 employment levels.

4.2 POPULATION/DISTRIBUTION

Population increase in the primary impact region outside the construction camp due to indirect employment could amount to some 600 people or 4%.

During operations an increase of about 2,000 people in the region represents an increase of 13% over and above the existing population of 15,000.

A population increase of 2,000 people during operations will likely be distributed across the primary impact region in a manner which reflects the size of existing urban communities and the distance of each community from the mill site. A certain percentage of people will live in the rural areas within commuting distance of the mill site. Without prejudicing where people will choose to live, an estimate of population distribution is made as follows:

Communities	Existing Population 1986	Estimated Increase	Estimated 1992 Population	% Increase
Athabasca/Boyle	2,648	925	3,573	35%
Lac La Biche/Plamandon	2,789	615	3,404	22%
Rural	<u>9,563</u>	<u>400</u>	<u>9,963</u>	<u>4%</u>
TOTAL	15,000	1,940	16,940	13%

4.3 HOUSING

A total of 665 housing units would be required to accommodate the demand for new housing in the Primary Impact Region. The present supply of residential lots in the urban and rural areas is summarized in Tables 12 and 13, respectively. It is likely that some existing vacant units will be rented along with suites in existing homes. This will tend to dampen the demand for new housing somewhat. However, it appears that the urban and rural communities in the area are more than capable of absorbing any anticipated population increase as a result of the project.

4.4 EDUCATION

An estimated 575 additional students will be added to the school systems in the primary impact region. Although on a regional basis this represents only about 30% of the available capacity, some pressure may be exerted upon schools in Lac La Biche, Plamondon, and Athabasca. An additional elementary school for both Lac La Biche and Athabasca may be required. This will be dependent upon population distribution and school attendance areas.

TABLE 12
RESIDENTIAL LOT SUPPLY IN MAIN URBAN
CENTRES, PRIMARY IMPACT REGION
1988

<u>Residential Land Supply</u>	<u>Athabasca</u>	<u>Boyle</u>	<u>Lac La Biche</u>	<u>Plamondon</u>	<u>Total</u>
Subdivided Lots					
o Serviced	170	21	48	4	243
o Unserviced	-	-	30	42	72
Raw Land (acres)	235	175 ¹	250	123	783
o Lots (Potential)	1,175	875	1,000	492	3,542
Total Lots	1,345	896	1,078	538	3,857

¹ Additional 140 acres pending an annexation decision (S.E. corner)

TABLE 13
RESIDENTIAL LOT SUPPLY IN RURAL
AREAS, PRIMARY IMPACT REGION
1988

<u>Residential Land Supply</u>	<u>Athabasca Area</u>	<u>Boyle/Skeleton Lake Area</u>	<u>Lac La Biche Area</u>	<u>Other</u>	<u>Total</u>
Subdivided Lots	146	105	80	184	515
Proposed	100	-	-	180	280
Total Lots	246	105	80	364	795

4.5 HOSPITALS

An additional 2,000 people in the primary impact region will likely cause an additional demand for 10 hospital beds based upon a standard of 5 beds per 1,000 people. This is well within the capability of the hospitals at Athabasca, Boyle, and Lac La Biche to absorb the increased demand. However, the hospital at Athabasca may need to be expanded to allow for normal growth since the utilization is now at 91%.

4.6 RECREATION AND TOURISM

Recreation services will need to be expanded due to the increase of 2,000 people. However, along with this increase, the provincial Community Recreation and Cultural Grant program will contribute \$20,000 additional resources into the municipal and community recreation budgets in 1991. A portion of the additional tax dollars gained by the County of Athabasca can be used to offset the costs of operating recreation facilities in Athabasca and Boyle through recreation agreements. In the case of Lac La Biche and Plamondon, some arrangement may be reached with the Province for additional assistance.

The location of the pulp mill is such that sulphur deposition and odour will not affect either the water quality of the Region's lakes or the proposed public tourism investments at Lac La Biche and Athabasca.

4.7 MUNICIPAL TAXES

The amount of municipal taxes payable by the company to the County of Athabasca is difficult to predict at this time but could range from \$1.6 million to \$4.0 million, annually. Taxation rates are usually determined during the negotiation process between the company, the County and the Province. Regardless of the amount of taxes payable, the revenue impact upon the County of Athabasca will be substantial (10

- 24% of current annual revenues). The County will likely need to carry out discussions with municipalities within its boundaries on cost sharing programs for recreation, etc.; as well the Province and I.D. #17 will likely require similar discussions with Plamondon and Lac La Biche.

4.8 TRANSPORTATION/UTILITIES

Regional transportation will be improved by upgrading some existing roads and by constructing two new highways (Figure 2). This will reduce the travel distance between Calling Lake and Lac La Biche by some 22 km.

A 36 km rail line will be built from Boyle to the mill site. This line will accommodate one train per day of pulp shipments out of the mill and one train per day in.

A 32 km, 138 kV line will be constructed from Dakin Lake west across Pine Creek and then due north to the mill site.

Natural gas is available on site from a 406.6 mm gas pipeline owned and operated by NOVA.

Wherever possible, the rail and power lines will be combined into a single transportation and utility corridor in order to minimize the impact of severance. However, this will be dependent upon the final selection of a rail route following preliminary engineering studies.

Truck traffic into the mill will consist largely of logging trucks. These trucks will transport both logs and chips into the mill. The routings and daily truck volumes are given in Table 14. Much of the truck traffic (41-48%) will originate from the Calling Lake/Wabasca area and will use SR 813 and the new proposed highway connecting SR 813

to the mill site via a new bridge across the Athabasca River. A slightly smaller percentage of traffic (36%) will come from the northeast via Highway 63 with the remainder of the traffic being shared between Highway 55 east and west. Gross vehicle weights of 60 tonnes will be used in the transport of logs to the site. A network of off-highway logging roads will eventually be built to minimize logging traffic on provincial highways.

TABLE 14
DAILY TRUCK VOLUMES FOR EACH HIGHWAY ROUTE
INTO THE MILL (ONE-WAY)

Truck Type	Highway 813 N.W.		Highway 63 N.E.		Highway 55 W		Highway 55 S.E.		Total All	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
Logs	229	68	165	49	20	6	39	13	453	136
Chips	-	-	10	10	15	15	3	3	28	28
Total	229	68	175	59	35	21	42	16	481	164
%	48	41	36	36	7	13	9	10		

Source Alberta-Pacific

5.0 LOCAL MILL SITE COMMUNITY

The local agricultural community in the mill site area consists of 60 - 65 families (about 200 people) and is known by the name Spruce Valley/Sandy Ridge. Other communities in the area include Willow Flats, Prosperity, Green Pine and Blue Jay. The closest urban community to all the agricultural communities in the immediate vicinity of the mill site is Grassland, located 20 km to the southeast. Grassland is a community of about 70 - 75 people with a school, outdoor recreation facilities, and commercial development. The school offers grades K-12 and has a capacity of 375 students with a present enrolment of about one half the rated capacity. Outdoor recreation facilities consist of a park, ball diamonds and an outdoor rink. The community has a water system which consists of a dugout and a well. At present 68 parcels of land are serviced. Sewage is collected by means of a low pressure gravity system to a double cell lagoon. A 22 unit motel is presently under construction and is expected to open in the spring of 1989. A 110 acre residential subdivision has been planned with the first stage consisting of 60 lots. Employment in Grassland is as follows:

Bulk Station	4
Husky Station	
- Store	6
- Restaurant	22
Grassland Community School	<u>18</u>
	50

Spruce Valley Mills Ltd. operates a sawmill in Spruce Valley which employs 30 people full time and 15 people part time. The mill produces stud lumber which is sold to Edmonton brokers.

The mill site community of Spruce Valley/Sandy Ridge contains an area of sand dunes on the south bank of the Athabasca River known as the Pine Sands Natural Area. No agricultural activity takes place within this natural area. This area was established by Order in Council 80/87 under Section 12.1 of the Wilderness Areas, Ecological Reserves and Natural Areas Act. This natural area covers an area of approximately 1350 ha (3330 acres). The Poacher's Landing Recreation Club has a Recreational Lease (Rec. 780026) comprising 15 ha (37 acres) adjacent to the Athabasca River in the eastern portion of the Natural Area. The recreational area includes a boat launch, playground and picnic/camping area. The Club also has a Licence of Occupation for the road to the lease.

The local road pattern is irregular and reflects the pattern of human settlement in relation to the better agricultural soils. In the area close to the river the soils are quite variable, ranging from muskeg to Class 3 agricultural soils. The actual mill site is on Class 4, Class 6 and organic (not classified) lands. There are two main county roads into the mill site: the Amber Valley/Prosperity Road and the Spruce Valley Road.

Prosvita Hall, the community hall for Spruce Valley/Sandy Ridge, Prosperity, Willow Flats, Green Pine and Blue Jay, is located at Prosperity. Local churches and cemeteries are located throughout the farming community.

6.0 PROJECT COMPONENTS WITH LOCAL EFFECTS

6.1 MILL SITE

The mill site is located on Sections 29 and 32, Tp. 68, R19 W4 in the County of Athabasca. The site is located about 47 km from the Town of Athabasca, 36 km from the Village of Boyle and 67 km from the Town of Lac La Biche.

The area of the site is 518 ha (1280 acres), not including a potential 800 m (1/2 mile) buffer zone. A log storage area 1.6 km in length will occupy the SW 1/4 of Section 32 and the NW 1/4 of Section 29 in a north-south direction. The mill will straddle the SE 1/4 of Section 32 and NE 1/4 of Section 29. The effluent treatment ponds will be located in the NE 1/4 of Section 32 and it is anticipated that an on-site landfill will be located in the SW 1/4 of Section 29.

6.2 CONSTRUCTION CAMP

It is planned to operate an on-site trailer construction camp designed to accommodate between 1400 and 1900 people for about a year and a half during 1990 and 1991. A small number of trailers (about 5) will be required on site in the fall of 1989 during site preparation and in the summer of 1991 just prior to mill start-up. The main advantages and disadvantages of an on-site construction camp are summarized below.

Advantages

- avoids undue strain on existing regional accommodation.
- significantly reduces the impacts of commuting traffic to and from the mill site.
- provides an opportunity for local companies providing catering and laundry services to bid on contracts.
- provides some supervision and control of the construction labour force.

Disadvantages

- temporary intrusion of 1400 to 1900 people into a community of 300 people.
- after-hours social impacts of construction workers upon local residents and facilities.
- possible introduction of alcohol and drugs into the community.

6.3 WATER INTAKE AND PIPELINE

A water intake will be built on the south bank of the Athabasca River where the existing NOVA pipeline crosses the river. The 5 km water line supplying water to the mill will follow the NOVA gas line right-of-way. The NOVA line crosses the Pine Sands Natural Area.

6.4 EFFLUENT LINE AND OUTFALL

An 8 Km effluent line will be constructed between the mill site and the Athabasca River. A defoaming pond will remove foam from the effluent prior to discharge to the river through a diffuser.

6.5 NEW AND UPGRADED ROADS

New and upgraded roads in the mill site area will be required to supply wood from Calling Lake and Highway 63, to provide construction/operation access into the mill and to provide alternate access to farms due to road closures within the plant site.

A new bridge will be built across the Athabasca River at the western edge of the Pine Sands Natural Area. A new highway from Calling Lake will be built to the mill site via the new bridge along the 18th Base Line. East of the mill site the new highway will veer south 1.6 km to avoid muskeg and join up with Highway 63, 21 km east of the mill.

These roads will be used by both construction and operations staff as well as by through traffic, but the major traffic will be wood haul. A southern highway link will be built from the site to Highway 55 on an alignment parallel to that proposed for the rail line on the quarter section line. This highway would be used during construction and operations for work force and supplies as well as for transporting wood. A 6 km upgrading of the existing county road west of the Grassland Highway 63 intersection will be required to link Highway 63 to the north-south site access highway.

Alberta-Pacific proposes to close between 5 and 7 km of local roads. Five kilometres of road closures are required within the mill site; the balance involves the existing road west of the millsite in Section 19. The County may consider this road to be redundant following the construction of a new provincial highway within 500 m to the east.

Approximately 8 km of new and upgraded roads will be built by Alberta-Pacific: a 4 km perimeter road along the eastern side of the site, a 2.5 km connector to the Highway 63 logging road and a 1.6 km addition to the local country road system to rejoin the Spruce Valley Road to the local road system west of the mill site. This latter road would allow remaining residents immediately east of the mill site the opportunity to visit neighbours west of the mill site without encountering significant industrial traffic. Approximately 5 km of new gravel roads will also be required to provide access to the water intake and effluent diffuser/defoaming ponds.

6.6 BOYLE RAIL SPUR

A 36 km rail line will be constructed from Boyle to the site. A preliminary rail corridor has been selected on the quarter section line commencing 800 m east of the Village of Boyle and routed due north to a point about 2 km north of Donatville, at which point it will cross

Highway 63/55 and Pine Creek. The line will gain the quarter section line due south of the millsite as soon as possible and proceed north into the mill site. Approximately 20 farmsteads will be affected within 800 m of the proposed rail alignment. By locating the railway along the quarter section line, the impact of severance and noise is minimized. Where farms are divided by the rail line, provisions will be made to allow the landowners to access land severed by the rail line.

6.7 GAS LINE RELOCATION

A 3 km relocation of the existing 406.6 mm NOVA gas transmission line will be required in order to allow land in Section 29 and 32 to be used as part of the log storage area. The relocated line will follow the new provincial highway on the west perimeter of the site and rejoin the original line at the southern boundary of Section 29.

6.8 POWER LINES

Construction power to the site will be provided via a tie to a 3-phase 25 kV line 13 km south at Highway 55.

Standby power during operations will be supplied via a 138 kV line constructed 20 miles northwest of an existing line between Boyle and Lac La Biche.

It is expected that both power lines will approach the site within the rail/access road corridor (Sections 6.5, 6.6).

7.0 LOCAL MILL SITE COMMUNITY IMPACTS

7.1 PEOPLE DISPLACED

There are 3 farmsteads within the mill site area that will be purchased by Alberta-Pacific. Fourteen people, representing about 7% of the existing local community, will be displaced. There are an additional 5 farmsteads within the 800 m buffer zone around the mill site, representing another 15 people. People presently living within the buffer area may or may not remain living there as the project proceeds, depending upon their preferences and Alberta-Pacific's land purchase policy.

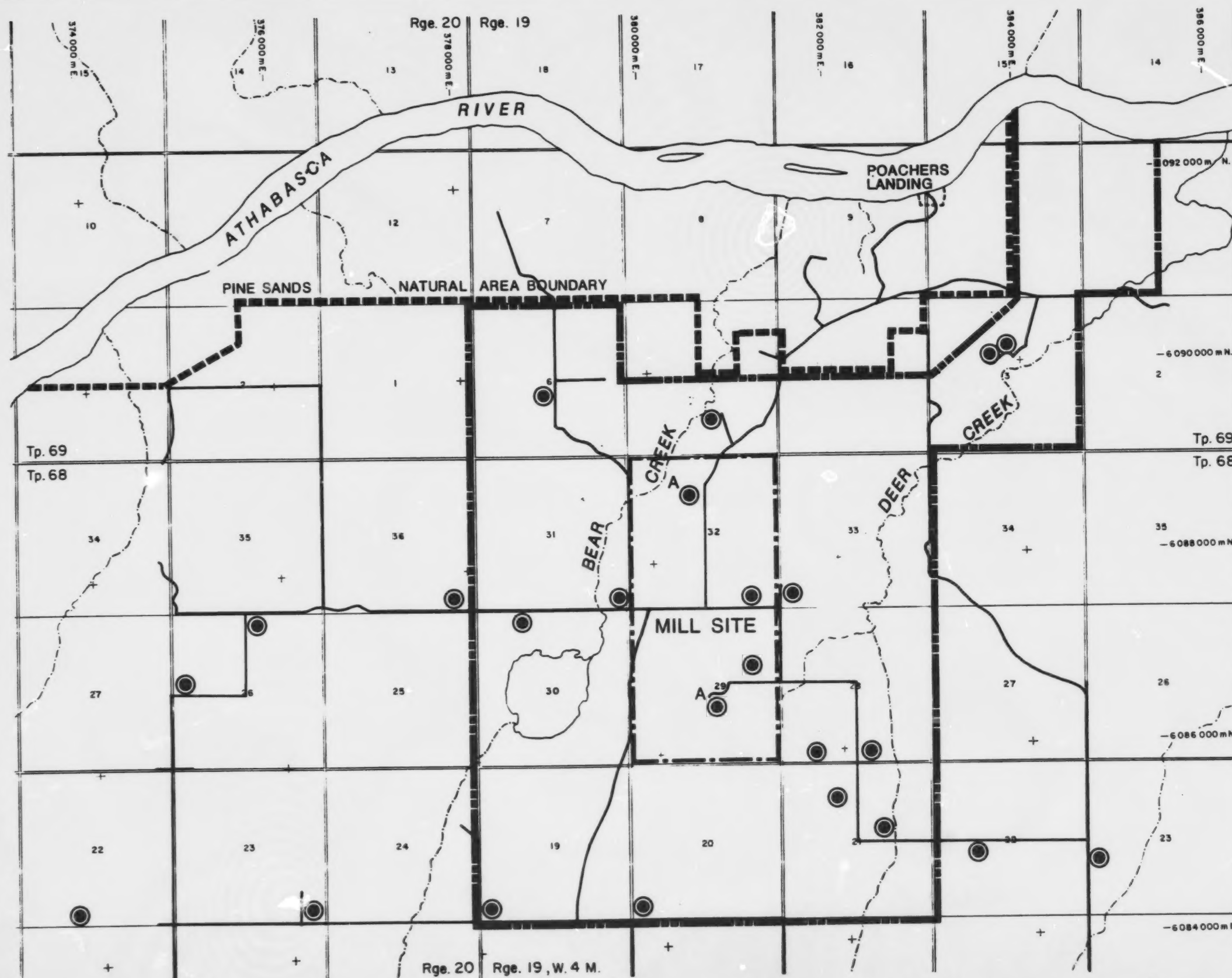
The main roles of the buffer zone around the mill site are:

- to allow for future expansion, particularly south and east; and
- to prevent incompatible development from occurring, especially between the lake and the plant site (western boundary).

Existing agricultural lands which are purchased in the buffer zone may be made available on a lease-back arrangement to the farming community or put to other uses such as experimental reforestation plots.

7.2 CONSTRUCTION

The present local community of about 200 people will experience temporary changes due to the construction of the pulp mill, roads, rail line and pipelines. Approximately 35 people will experience some disruption during the construction of the mill site and infrastructure in what has been described as the local development area. This covers an area of 34 square kilometers (Figure 3).



NORTH ↑

LEGEND

- EXISTING ROADS
- LOCAL DEVELOPMENT AREA
- EXISTING FARMSTEADS
- A ● ABANDONED FARMSTEADS

SCALE

0 500 1000 2000m

Appendix 4

Figure 3

MILL SITE
LOCAL DEVELOPMENT AREA



There will be a temporary intrusion of 1400 to 1900 people in a 50 trailer construction camp at the mill site. This impact will be shortlived and will last approximately a year and a half through 1990 and into 1991. Until the new highway is constructed south from the site to Highway 55, the Spruce Valley Road will be used to transport construction materials to the site. Construction workers hired from the region will commute daily to the site via the existing Amber Valley and Spruce Valley roads.

Road closures in the mill site will cut off some traditional communication links within the northern edge of the Spruce Valley/Sandy Ridge farming community; however, alternative road access will be provided and the local transportation network will not be functionally altered. The present school bus route (J. Zachkewich) which passes through the millsite would have to be altered. Alternative access to pick up children living north and east of the site would be provided by either an eastern site perimeter road or by an extension of the Spruce Valley road and the new provincial highway.

Beyond the local development area, construction impact will be focussed upon a transportation/utility corridor about 110 m wide which is routed south from the mill site to Highway 55 along the quarter section line. The development of this corridor will impact upon 11 farmsteads.

The impact on the Pine Sands Natural Area will be minimized. The plant site is located about 2 km south of the Natural Area. The extreme western edge of the Natural Area will encompass the highway bridge and it is proposed that the existing NOVA pipeline corridor crossing of the Natural Area be used as the alignment for the water line from the Athabasca River to the mill.

The water line will run adjacent to and west of the NOVA pipeline in its own right-of-way. The intake and pumphouse will be located some distance west of the NOVA pipeline so as to not disturb the existing gas line. The water pipeline will extend up the river bank to a point beyond the normal slippage area and adjoin the NOVA right-of-way at a more stable point on top of the river bank. An access road will be built to the pumphouse and intake structure in a narrow right-of-way so as to minimize the amount of land required. The road will be closed by means of a gate and fence. Disturbed soil will be promptly revegetated with appropriate species in order to minimize erosion.

The effluent line will not affect the Natural Area.

The use of the Natural Area by construction workers will be discouraged during construction to minimize contact with local residents. During operations some further recreational development of either the Natural Area or adjacent areas might be possible for use by the community and mill workers.

The visual impacts of the mill will be mitigated by landscaping as appropriate.

7.3 OPERATIONS

Employment during operations in the Athabasca/Lac La Biche Region will amount to 440 people at the pulp mill. A further 150 jobs will be associated with forest harvesting, and indirect and induced employment is expected to add another 450 jobs in the immediate region. It is estimated that about 50% of the jobs will be created in Athabasca/Boyle, with about 30% going to Lac La Biche/Plamondon and the remaining 20% to the rural areas.

It is presently proposed that 12-hour shifts will be used in the mill (24 hours a day operation), with office hours being 8 hours per day. The mill tour of duty will be 3 days on and 3 days off. During the day, a total of 150 people will be on site.

Wood will be hauled to the log and chip storage areas via Highway 813 and Highway 63. The majority of the wood haul will take place over the winter months with anticipated daily truck volumes being 230 from Calling Lake and 175 from Highway 63. These are significantly high volumes of truck movements but the impact will be minimized by the fact that the proposed highways pass mainly through undeveloped crown lands.

Other transportation impacts include the movement of some .30 rail cars per day of air dried pulp, 345 days per year. On average, 5-6 rail cars daily will be brought into the millsite to supply chemicals.

APPENDIX 5 SITE SELECTION STUDY

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1.0 INTRODUCTION

Stanley Associates Engineering Ltd. (Stanley) was retained by Crestbook Forest Industries Ltd. (CFI) in June 1988 to locate and recommend a site, and to identify infrastructure requirements for a 1500 ADMT per day Bleached Kraft Pulpmill in the Athabasca/Lac La Biche area of Alberta. This study was conducted during the months of June and July and this Final Report completed in August.

1.1 TERMS OF REFERENCE

The terms of reference for this site selection and infrastructure study (Task 1) was contained in Mr. E.H. Jackson's letter of May 20, 1988 and modified by Stanley's proposal dated May 30, 1988. This first task was divided into 13 sub-tasks as follows:

Sub-Task	1	Background Data	
Sub-Task	2	Field Visit	- Helicopter Reconnaissance
Sub-Task	3	Site Evaluation	- CFI Requirements
Sub-Task	4	Site Evaluation Matrix (Costs)	- Land
Sub-Task	5	Site Evaluation Matrix (Costs)	- Land
Sub-Task	6	Site Evaluation Matrix (Costs)	- Wastewater
Sub-Task	7	Site Evaluation Matrix (Costs)	- Solid Waste
Sub-Task	8	Site Evaluation Matrix (Costs)	- Utilities
Sub-Task	9	Site Evaluation Matrix (Costs)	- Road and Rail
Sub-Task	10	Site Evaluation Matrix (Costs)	- Site Preparation/ Foundation
Sub-Task	11	Site Evaluation Matrix	- Environmental
Sub-Task	12	Site Evaluation Matrix	- Socio-Economics
Sub-Task	13	Site Recommendation	

1.2 SCOPE

The Scope of work was to evaluate potential sites for mill development in the Athabasca/Lac La Biche area in relatively close proximity to the Athabasca River (Figure 1). A location downstream of the Town of Athabasca was considered essential as a result of river modelling studies carried out for CFI by Stanley.

The economic evaluation of each infrastructure item for purposes of site selection was to consider not only the capital cost but the operating cost over 20 years of operation. Other factors such as the quality of life available to future employees of the mill were also to be taken into account together with environmental impact factors. Site assessments for the mill were to also include an evaluation of soil conditions, hydrology, grading requirements and foundation conditions.

1.3 MILL INFRASTRUCTURE REQUIREMENTS

The mill requirements assumed for the purposes of selecting a site were given by CFI as follows:

Wood Required: 2,730,000 m³/year

Mill Site: 1.6 km x 2.5 km or 400 ha.
100 ha for mill (250 ac)
200 ha for wood/chip storage (500 ac)
60 ha for effluent treatment

The above area excludes:

Utility R.O.W. - new & existing services
Dump site
Borrow pits
100 ha for future expansion
buffer zone



Figure 1



**CRESTBROOK FOREST INDUSTRIES
INDUSTRIAL FOREST DEVELOPMENT
LOCATION WITHIN ALBERTA**



Water:	1.5 m ³ /second		
Wastewater:	90% return or 1.35 m ³ /second. Aerated lagoon treatment system on each site.		
Rail:	30 cars/day air dried pulp -345 day/yr 5 - 6 cars/day inbound - chemicals		
Power:	3-phase 25 kV line for construction 30 MW, 138 kV standby tie to Alberta Grid		
Gas:	Base load	1.0	MMcf/d
	Hog fuel deficiency	2.7	MMcf/d
	TOTAL	3.7	MMcf/d
Solid Wastes:	45 - 60,000 m ³ /yr		
(subject to change)	(i.e. ash, wood yard debris, dregs & grits refuge) preferably disposed at landfill onsite		
Air Emissions:	SO ₂	9.4 tonnes/day	
(subject to change)	TRS	0.1635 tonnes/day	
	Particulates	7.0 tonnes/day	
Employment:			
	Construction:	Plant 27,000 man-months over 3 years -peaks @ 1250 people	
	Operation:	Plant 440 (year round) FMA 660 (full time equivalent)	
Agricultural Land:	Only sites located on poorer agricultural lands considered (Class 4 or higher)		

Commute Time: Only sites within 45 minutes of one-way commute time from either the Town of Athabasca or the Town of Lac La Biche considered acceptable.

Proximity to Major Centres: Sites which are within the daily commuting time limit of 45 minutes from both Athabasca and Lac La Biche are preferred due to the desire to soften any impact and to spread the benefits.

2.0 POTENTIAL MILL SITES FOR EVALUATION

2.1 IDENTIFIED SITES

A total of nine (9) general sites were chosen for evaluation as to their suitability for a mill location in the Athabasca/Lac La Biche Region. These nine (9) sites are shown in Figure 2. Seven (7) of the sites lie within the County of Athabasca, one in I.D. 17 and one in I.D. 18. Five (5) of the sites are located adjacent to the Athabasca River downstream of the Town of Athabasca, and four (4) are located some distance from the river adjacent to major highways. Site #7 was chosen as it is adjacent to the major industrial rail line at Boyle to minimize the cost of road and rail. Two of the sites (#4 and #2) had one alternative each, other than the main site considered.

2.2 APPROACH

The approach taken to comparing the nine (9) sites for their suitability as a pulp mill site involved using a differential cost analysis with Site #2a as a base. In other words each infrastructure item (eg. water, rail, etc.) was assigned a cost value for the **difference** in cost at each site compared to Site #2a. In this manner, unnecessary effort in estimating the capital cost of infrastructure common to all sites was avoided. For example the cost of a water treatment plant was assumed to be equal to all sites since water from the Athabasca River is the source for all nine (9) sites. Therefore, only the difference in pump size and length of water line were costed from each site when considering the supply of water. A similar approach was taken with all other forms of infrastructure.

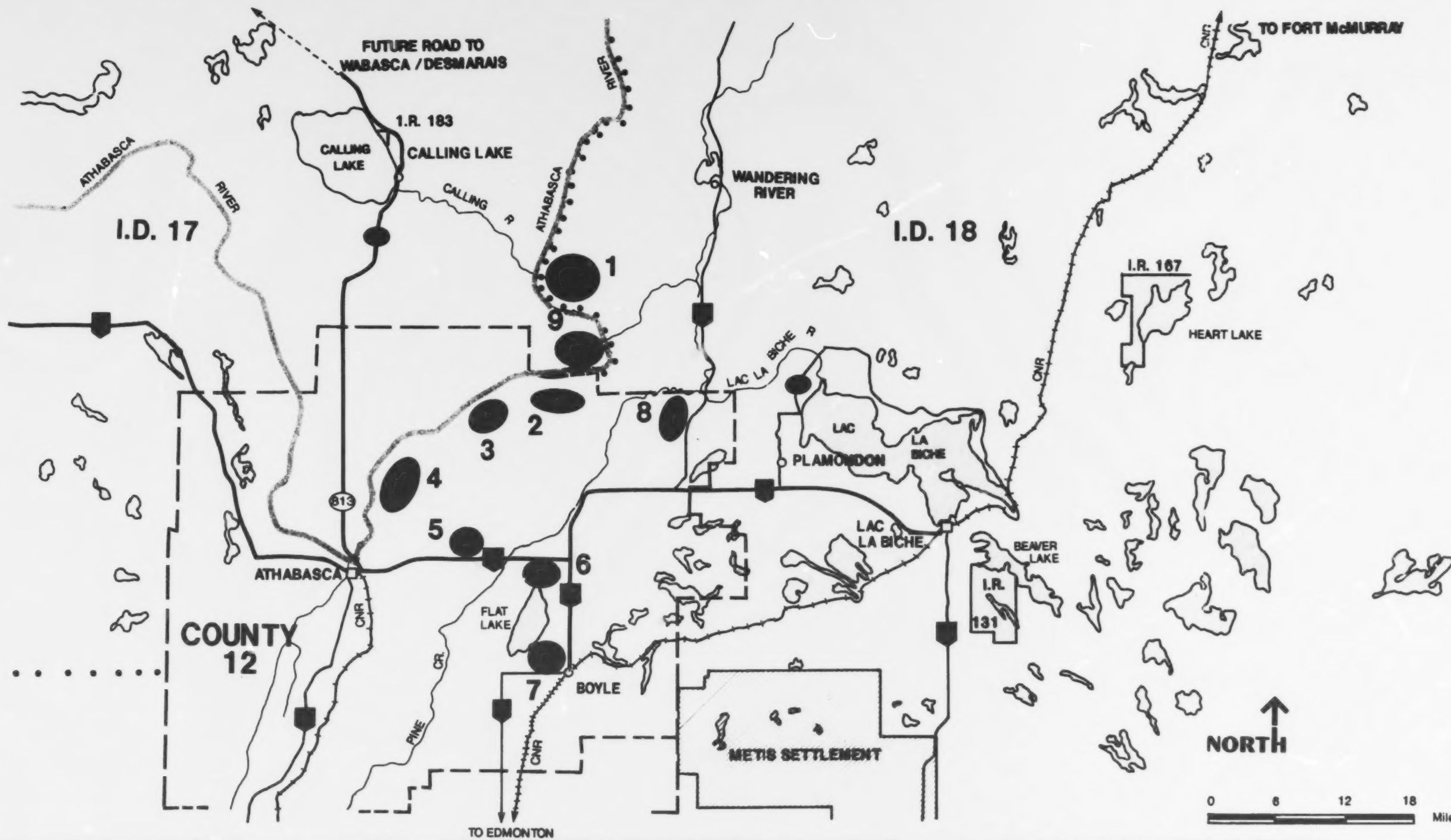


Figure 2

-  SITES FOR EVALUATION
-  LAKES AND WATERWAYS

CRESTBROOK FOREST INDUSTRIES
INDUSTRIAL FOREST DEVELOPMENT

ATHABASCA/LAC LA BICHE REGION
SITES FOR EVALUATION FOR
MILL DEVELOPMENT





3.0 SITE EVALUATION

The characteristics of the nine (9) sites chosen for evaluation as shown in Figure 2 are summarized in Table 1. A detailed description of each site and its characteristics follows. Maps showing the general location of each site are shown on figures contained within Appendix B.

3.1 **SITE #1 (Figure B-1)**

Site #1 is located approximately 45 miles downstream of the Town of Athabasca on the east bank of the Athabasca River in I.D. #18. The site was once connected to the west bank of the Athabasca River by a ferry, linking two segments of a road between Calling Lake and Wandering River.

3.1.1 **Land**

The land at Site #1 consists of alluvial terraces on the east bank of the Athabasca River in I.D. #18. The soils are layered as gravel and sand over till or bedrock. The elevation of the plant site is about 1800 feet above sea level (source: 1:50,000 topographical maps) and due to the nature of the soils spread footings on a compacted gravel pad would be required for the mill. Present land ownership on the site area is predominantly crown lands with three quarter sections owned privately. The site is fairly well treed with some clearing having already taken place on privately held lands and at the gravel pit. Minimal site grading would be required and granular materials are available on site.

3.1.2 **Water**

Based upon a river elevation of 1600 feet, a 200 foot lift of water from the Athabasca River to the mill is required. A 36 inch diameter pipeline (6000 feet) and 3 pumps at 900 horsepower each would be required.

TABLE 1
SUMMARY OF SITE CHARACTERISTICS

Site #	Elevation m	Distance To Athabasca River km	Distance To Rail @ Boyle km	Length of Road Required km	Distance To 138 KV Line km	Distance To Gas Line km	Land Capability for Agriculture	Land Use Designation	Athabasca	Boyle	Distance to Major Communities by Road (mi)	Lac Le Biche
1	550	2	56	55	48	5	Class 6	Agricultural	67	38	36	
2	550	5	53	64	32	-	Class 6	Agricultural	27	25	42	
3	580	1	40	66	37	9	Class 3	Rural	25	30	48	
4	620	2	39	77	23	8	Class 6	Rural	13	36	64	
5	595	15	23	63	19	11	Class 6	Agricultural	9	19	49	
6	595	26	16	63	19	1	Class 6	Agricultural	16	14	63	
7	620	41	3	63	5	1	Class 6	Rural	28	1	47	
8	570	22	29	52	18	6	Class 6	Rural	38	29	30	
9	550	2	42	68	39	9	Class 6	Agricultural	36	29	46	
2a	550	3	36	66	32	2	Class 3	Rural	32	25	62	

3.1.3 Effluent

Liquid effluent would be treated on site using an aerated lagoon system. Flow to the river, downstream of the water intake would be by gravity. A 36 inch outfall line would be required over a distance of slightly less than 6000 feet.

3.1.4 Road

Roads into Site #1 would be required from both Highway 63 and the Calling Lake Highway (SR 183). A low level highway bridge across the Athabasca River would be required on the existing road alignment. The distance to Highway 63 is about 16 miles and about 18 miles from the proposed bridge to the Calling Lake Highway.

3.1.5 Rail

A 35 mile connection built from Boyle would be required to service Site #1 with rail.

3.1.6 Electrical

Construction power is available along Highway 63 from a 3-phase 25 kV line. A new 12 mile line would therefore be required to provide construction power to Site #1.

Standby power capable of delivering 30 MW during emergencies is available in this area from a 138 kV line, located 30 miles southeast of the site at Highway 55.

3.1.7 Natural Gas

Natural gas supply to Site #1 can be supplied off the NOVA Calling Lake line, west of the Athabasca River. A river crossing would be required in conjunction with the highway bridge.

3.1.8 Environmental

Land capability for agriculture at Site #1 is rated under the Canada Land Inventory at Class 4 but exhibiting an undesirable soil structure. The potential for ungulate habitation on Site #1 is fairly high. Expected populations would include moose and deer.

The water quality at Site #1 should be the highest with respect to dissolved oxygen and the site is well positioned regarding population centres and prevailing winds to minimize odour problems.

3.1.9 Socio-Economic

Site #1 is located 67 road miles from Athabasca and 54 road miles from Lac La Biche. As such this is beyond the 45 minute limit for daily commuting. Therefore, this site is classified as a remote site and would likely require either a new town or an operations residential camp on site. Site #1 is designated for agricultural use (A1) under I.D. #17's Land Use District Map (Land Use Order NO. 1 - July 29/81). A pulp mill would be a Discretionary Use under the Agricultural District 1 "A1" (Natural Resource Extraction Industry).

3.2 SITE #2/SITE 2a (Figures B-2 & B-2a)

A second site location is approximately 30 miles downstream of the Town of Athabasca. The site is situated on the south bank of the Athabasca River in the County of Athabasca. Two possible mill sites were identified and are labelled as Site #2 and Site #2a.

3.2.1 Land

The land at Sites #2/2a in the County of Athabasca is quite variable and ranges from sand dunes and lacustrine soils near the river to outwash planes, 2 miles south of the river. The soils vary from sand over lacustrine clay over till or bedrock near the river to gravel and sand overlying till further back from the

river. The water table is relatively deep (greater than 30 feet deep) near the river to within 10 feet perched on the till within 2 miles of the river. The elevation varies between 1800 feet near the river to 1900 feet further back (source: 1:50,000 topo maps). Foundation conditions near the river require spread footings on compacted pads and pile foundations for heavy tanks and equipment. Foundation conditions further back (2 miles) require spread footings on compacted pads with no requirement for piles. Gravel is available on site and in the local area. Present land ownership is predominantly in private hands and is under cultivation with crown lands on the fringes (generally on wet lands). The site is mostly cleared and the site grading required is minimal back from the river and increases toward the river.

3.2.2 Water

Using a plant elevation varying between 1800 and 1900 feet and an assumed river elevation of 1625 feet a 175-275 foot lift of water from the Athabasca River is required. A 36 inch pipeline varying in length from 8500 to 17,500 feet would be required. Three installed pumps, each varying between 800 and 1500 horsepower, would be required.

3.2.3 Effluent

Liquid effluent would be treated on site using an aerated lagoon system. Flow to the river, well downstream of the water intake, would be by gravity. A 36 inch outfall line would be required over the 8500 to 17500 foot distance.

3.2.4 Road

A low level highway bridge would be built across the Athabasca River at Site #2a with highways constructed from the bridge west to the Calling Lake Highway (SR 813) and south to Highway 55. The distance to SR 813 is about 22 miles and the distance to Highway 55 is about 25 miles (Site #2) and 29 miles (Site #2a). A road link to the bridge is about 5 miles in the case of Site #2 and 1 mile for Site #2a. A road link to Highway 63 for wood haul purposes would be 11 miles.

3.2.5 Rail

A 22 mile rail construction from Boyle is required to service Site #2.

3.2.6 Electrical

Construction power (3-phase -25 kV) is available eight (8) miles south at Highway 55.

Standby power can be supplied via a 138 kV line constructed 20 miles northwest of the existing line near Highway 55.

3.2.7 Natural Gas

Natural gas supply to Site #2 is available through NOVA's 406.6 mm (O.D.) line which tranverses the site. It may become necessary to relocate this line to the west boundary of the site. An allowance of 2 miles should be made as a requirement @ \$500,000 per mile. However, this cost has not been included in the analysis at this time.

3.2.8 Environmental

Land capability for the agriculture for Site #2 is rated under the Canada Land Inventory at Class 4 and Class 6 with Soil limitations. The potential for ungulate habitation on Site #2 is good for wintering on the banks of the river.

The water quality at Site #2 is good and the site is satisfactory from an air quality point of view.

3.2.9 Socio-Economic

Site #2 is located 32 miles from the Town of Athabasca, 42 miles from Lac La Biche, and 25 miles from Boyle. Therefore, these are three population centres which are within daily commuting distance of the site. Site #2 is designated as

an Agricultural Use District (AU) under the County's Land Use Bylaw No. 10-1987 and the pulp mill would be a discretionary use within this land use zone (Natural Resource Extraction).

3.3 SITE #3 (Figure B-3)

Site #3 is located approximately 20 miles downstream of the Town of Athabasca. The site is situated on the south bank of the Athabasca River in the County of Athabasca.

3.3.1 Land

The Land at Site #3 consists of ground moraine on the south bank of the Athabasca River in the County of Athabasca. The soils in this area consist of a thin lacustrine clays over till over bedrock. The elevation of the mill site is about 1900 feet above sea level (source: 1:50,000 topo maps) and due to the nature of the soils, spread footings on till on compacted pads would be required along with piles for selected tanks. Present land ownership over the site area is predominantly private lands with some crown lands on the finges. The site is mostly cleared and fields are under cultivation. A potential gravel source is located nearby; and due to the rolling topography, a fair amount of site grading would be required.

3.3.2 Water

Using a river elevation of 1625 feet, a 275 foot lift of water is required. An assumed pipeline (36" diameter) length of 4500 feet and three (3) pumps rated at 1200 horsepower each would be required.

3.3.3 Effluent

Liquid effluent would be treated on site using an aerated lagoon system. Flow to the river, well downstream of the water intake would be by gravity. A 36 inch outfall line would be required over a distance of slightly less than 4500 feet.

3.3.4 Road

Roads into Site #3 would be required from Highway 55 and from the Athabasca highway bridge located at Site #2. The distance to Highway 55 is about 32 miles with an additional 3 miles of road required to link the road network to the bridge. As with the other alternatives, a 22 mile link from the north end of the bridge to SR 813 would be built as well as an 11 mile wood haul road to Highway 63.

3.3.5 Electrical

Construction power is available at Prosperity, a distance of 10 miles from Site #3. A 3-phase 25 kV line would be constructed to provide Site #3 with suitable power during construction.

Standby power capable of delivering 30 MW during emergencies is available from a 138 kV line near Highway 55.

3.3.7 Natural Gas

Natural gas supply to Site #3 can be provided off the NOVA Calling Lake Line which passes through Site #2, five miles east of Site #3.

3.3.8 Environmental

Land capability for Agriculture of Site #3 is rated under the Canada Land Inventory at Class 5 and exhibits moisture deficiency. The potential for ungulate habitation on Site #3 is reasonably high.

The water quality at Site #3 should be good and the site is located sufficiently far away from population centres to not pose a serious air quality odour problem.

3.3.9 Socio-Economic

Site #3 is located about 25 road miles from the Town of Athabasca and about 48 miles from Lac La Biche. As such it is at the limit of daily commuting from Lac La Biche. Therefore, it is not expected that very many people would choose to live in Lac La Biche during mill operations compared to Athabasca and Boyle. The land at Site #3 is presently classified as a Rural Use District (RU) under the County's Land Use Bylaw No. 10-1987 and a pulp mill is a Discretionary Use (Natural Resource Extraction).

3.4 SITE #4 (Figure B-4)

Site #4 is located about 10 miles downstream of the Town of Athabasca on the south bank of the Athabasca River in the County of Athabasca.

3.4.1. Land

The land at Site #4 in the County of Athabasca consists of a ground moraine (ridged) plus thin peat. The soils improve the closer you are to the Athabasca River. The soil for the most part is a till over bedrock with water at the surface in the peat areas. The elevation of the mill site varies between 1975 and 2025; the lower elevation is in the vicinity of Jackfish Lake (source: 1:50,000 topo maps). The soils would likely require spread footings on till or a compacted pad (dependent upon the depth to till) for the development of the mill. Present land ownership is private near the river and public lands near Jackfish Lake. The site is cleared and cultivated near the river and treed near Jackfish Lake. From a site grading perspective this site would likely be the most expensive to develop of all the sites. There is also no readily apparent source of granular materials nearby.

3.4.2 Water

Using a river elevation of 1625, a 350 - 400 foot lift of water is required to provide water on site. A 36 inch pipeline varying in length from 6000 to 18,000 feet would be required with 3 pumps installed, each varying between 1550 and 2000 horsepower.

3.4.3 Effluent

Liquid effluent would be treated on site using an aerated lagoon system. Flow to the river, well downstream of the water intake, would be by gravity. A 36 inch outfall line would be required over a distance of slightly less than 6000 to 18,000 feet.

3.4.4 Road

Roads to service Site #4 would be required from Highway 55 and from the bridge at Site #2. As with the other sites, a road link from the north bank of the River at the bridge to SR 813 would also be required. The distance to Highway 55 is about 29 miles and to the bridge is about 10 miles. The link to SR 813 is 22 miles.

3.4.5 Rail

A 24 mile rail connection to Boyle would be required to service Site #4.

3.4.6 Electrical

Construction power is available at the Town of Athabasca from a 3-phase 25 kV line. A new 12 mile line would be required to link Site #4 with this source of construction power.

Standby power capable of delivering 30 MW during emergencies is available from a 138 kV line on Highway 663, 3 miles east of Colinton (14 miles).

3.4.7 Natural Gas

Natural gas can be supplied to Site #4 from the Baptiste gas transmission line, located 5 miles from the site.

3.4.8 Environmental

Land capability for Agriculture for Site #4 is rated under the Canada Land Inventory as Class 4 with soil limitations. The potential for ungulate habitation on Site #4 is relatively high but lower than Sites 1, 2, 3, and 9.

The water quality at Site 4 would be fair. The site is poorly positioned regarding its close proximity to the Town of Athabasca from the point of view of both air quality (odour, inversions, etc.) and aesthetics (visual impact).

3.4.9 Socio-Economic

Site #4 is located approximately 13 road miles from Athabasca and 64 miles from Lac La Biche. Therefore, very few people if any would live in Lac La Biche and commute daily to the mill, especially under winter conditions. Relative to the other sites, this would place a disproportionate pressure upon the infrastructure in Athabasca to accommodate the population growth that would accompany this development.

The site is classified as being in the Rural Use District (RU) under the County's Land Use Bylaw No. 10-1987. A pulp mill is a Discretionary Use under the Rural Use District (Natural Resource Extraction).

3.5 SITE #5 (Figure B-5)

Site #5 is located in the County of Athabasca, approximately 10 miles east of the Town of Athabasca, on the north side of Highway 55.

3.5.1 Land

The land at Site #5 in the County of Athabasca consists of a ground moraine. The soil consists of thin lacustrine clays over till over bedrock. The elevation of the mill site is 1950 feet (source: 1:50,000 topo maps). The soils would likely require the construction of spread footings on till or compacted fill with piles on selected tanks. Present land ownership is mostly private with some crown lands on the fringes. The site for the most part is cleared and under cultivation. Minimal site grading would be required due to the relatively flat topography and good soil conditions. There is no readily identifiable gravel source nearby.

3.5.2 Water

Using a river elevation of 1650 feet, a 300 foot lift of water is required. A 36 inch pipeline would be required to be built over a distance of some 48,000 feet with 3 installed pumps at 2000 horsepower each.

3.5.3 Effluent

Liquid effluent would be treated on site using an aerated lagoon system. Flow to the river, well downstream of the water intake, would be by gravity and pumpstation. A 36 inch outfall line would be required over a distance of 48,000 feet.

3.5.4 Road

Site #5 is located adjacent to Highway 55 on the north side. A 14 mile road link to the Athabasca River Bridge at Site #2 would be required along with a 22 mile link from the north side of the bridge to SR 813.

3.5.5 Rail

A 14 mile rail link to Boyle would be required to service Site #5.

3.5.6 Electrical

Construction power is available at Prosperity, 8 miles north and east of Site #5. A new 8 mile line (3-phase 25 kV) would therefore be required.

Because of its remote location relative to the Athabasca River, a 3-phase 25 kV line would be required to be constructed 5 miles from the Town of Athabasca to a point downstream of the town at the water intake location.

Standby power capable of delivering 30 MW during emergencies is available from a 138 kV line at Kinikinik on Highway 663 (12 miles).

3.5.7 Natural Gas

Natural gas can be supplied to Site #5 from the Baptiste gas transmission line, located 6 miles from the site.

3.5.8 Environmental

Land capability for Agriculture for Site #5 is rated under the Canada Land Inventory as Class 4 with soil limitations. The potential for ungulate habitation is relatively low.

The water quality at the proposed intake location is only fair. The site is only marginally better positioned related to Site #4 from an air quality point of view (odour). The location of a pulp mill at Site #5 would also present quite a visual impact as viewed from the upper benches of development in the Town of Athabasca.

3.5.9 Socio-Economic

Site #5 is located approximately 9 miles from Athabasca and 49 miles from Lac La Biche. As with Site #4, the development of a pulp mill at this location would likely place a disproportionately high impact upon the Town of Athabasca.

The site is classified as being in the Agriculture Use District (AU) under the County's Land Use Bylaw No. 10-1987. A pulp mill is a Discretionary Use under this district (Natural Resource Extraction).

3.6 SITE #6 (Figure B-6)

Site #6 is located in the County of Athabasca on the south side of Highway 55, approximately 14 miles east of the Town of Athabasca.

3.6.1 Land

The land at Site #6 in the County of Athabasca consists of a ground moraine. The soils consists of thin lacustrine clays over till over bedrock. The elevation of the mill site is 1950 feet above sea level (source: 1:50,000 topo maps). The soils would likely require the construction of spread footings on till or compacted fill with piles on selected tanks. Present land ownership is private. The site is mostly cleared and under cultivation. Minimal site grading would be required due to the relatively flat topography and good soil conditions. There is some evidence of small gravel sources nearby but these are not considered significant.

3.6.2 Water

Using a river elevation of 1650 feet above sea level, a 300 foot lift of water over 84,000 feet would be required. This would necessitate building a 36 inch pipeline from the River to the site and require 3 pumps at 2500 horsepower each.

3.6.3 Effluent

Liquid effluent would be treated on site using an aerated lagoon system. Flow to the river, well downstream of the water intake would be by gravity and pumps over a distance of 84,000 feet.

3.6.4 Road

Site #6 is located adjacent to Highway 55 on the south side. A 14 mile road link to the Bridge at Site #2 would be required along with a 22 mile connection from the north end of the bridge to SR 813.

3.6.5 Rail

A 10 mile rail connection to Boyle would be required to service Site #6.

3.6.5 Electrical

Construction power consisting of a 3 phase 25 kV line can be provided from Prosperity, 7 miles north of Site #6.

Similar to Site #5, a 3 phase 25 kV line (5 miles) would be required to service the remote water intake location at the Athabasca River near the Town of Athabasca.

Standby power capable of delivering 30 MW during emergencies is available from a 138 kV line at Boyle (12 miles).

3.6.7 Natural Gas

Natural gas can be supplied to Site #6 from the Flat Lake line, located about a mile from the site.

3.6.8 Environmental

Land capability for Agriculture for Site #6 is rated under the Canada Land Inventory as Class 4 with soil limitations. The potential for ungulate habitation is relatively low.

The water quality at the proposed intake location is only fair. The site is about 10 miles upwind of Boyle. A pulp mill developed at this site would be visible from both Athabasca and Boyle.

3.6.9 Socio-Economic

Site #6 is located 14 road miles from both Athabasca and Boyle. The site is located about 43 miles from Lac La Biche and is within daily commuting distance of that community. Development at this site would tend to draw more evenly from the surrounding towns than development at Sites 4 and 5.

The site is within the Agricultural Use District (AU) under the County's Land Use Bylaw No. 10-1987. A pulp mill is a Discretionary Use under this land use district (Natural Resource Extraction).

3.7 SITE #7 (Figure B-7)

Site #7 is located adjacent to the Village of Boyle in the County of Athabasca. The site was chosen in such a manner as to provide easy rail access on the northern edge of the Village.

3.7.1 Land

The land at Site #7 in the County of Athabasca at Boyle consists of a ground moraine. The soil profile is a thin lacustrine clay over till over bedrock. The elevation of the mill site is 2025 feet above sea level (source: 1:50,000 topo maps). The soils would likely require the construction of spread footings on till or compacted fill with piles on selected tanks. Present land ownership is private. The site is mostly cleared and under cultivation. Minimal site grading would be required due to the relatively flat topography and good soil conditions. Gravel deposits are available in the Amisk Lake area.

3.7.2 Water

Using a river elevation of 1650 feet above sea level, a 375 foot lift of water over 133,000 feet would be required. This would necessitate building a 36 inch pipeline from the river to the site with 3 pumps rated at 3600 horsepower each.

3.7.3 Effluent

Liquid effluent would be treated on site using an aerated lagoon system. Flow to the river would be by gravity, aided by pumps to a point well downstream of the water intake.

3.7.4 Road

A 14 mile road link from Highway #55 to the bridge at Site #2 would be required along with a 22 mile connection from the bridge to SR 813.

3.7.5 Rail

A 2 mile rail connection to the CNR line at Boyle would be required to service the site.

3.7.6 Electrical

Construction power is available at Boyle (4 miles).

Similar to Site #5, a 3 phase 25 kV line (5 miles) would be required to service the remote water intake location on the Athabasca River near the Town of Athabasca.

Standby power capable of delivery 30 MW during emergencies is available from a 138 kV line at Boyle (3 miles).

3.7.7 Natural Gas

Natural gas is available from the Atmore East line located 1 mile away from Site #7.

3.7.8 Environmental

Land capability for Agriculture for Site #7 is rated under the Canada Land Inventory as Class 4 with limitations due to excess water. The potential for ungulate habitation is relatively low.

The water quality at the proposed intake location is only fair due to its proximity to the Town of Athabasca. The site is at Boyle and would likely be environmentally unacceptable to town residents due to odour problems and the visual impact of such a development.

3.7.9 Socio-Economic

The socio-economic impact of such a development at Boyle would be considerable upon Boyle and Skeleton Lake. Boyle alone does not have the infrastructure capacity to accept the growth that would come with the development of a pulp mill. Also, lifestyle considerations at Skeleton Lake would likely come into conflict with the development of a pulp mill at Boyle which is upwind of the lake.

The site is within the Rural Use District (RU) under the County's Land Use Bylaw No. 10-1987. A pulp mill is a Discretionary Use under the land use district (Natural Resource Extraction).

3.8 SITE #8 (Figure B-8)

Site #8 is located 6 miles north of the junction of Highways 63 and 55 on Highway 63 in the County of Athabasca. The closest town to the site is Lac La Biche which is located 30 miles away.

3.8.1 Land

The land at Site #8 in the County of Athabasca consists of ground moraine. The soil profile is a thin lacustrine clay over till over bedrock. The elevation of the mill site is 1875 feet above sea level (source: 1:50,000 topo maps). The soils would likely require the construction of spread footings on till or compacted fill with piles on selected tanks. Present land ownership is private with public land on the fringes. The site is partially cleared and under cultivation. Minimal site grading would be required due to the relatively flat topography and good soil conditions. Gravel deposits are available in the area in the vicinity of Site #1.

3.8.2 Water

Using a river elevation of 1625 feet above sea level, a 250 foot lift of water over a distance of 72,000 feet would be required. A 36 inch pipeline with three 2100 horsepower pumps would be built to provide raw water to Site #8.

3.8.3 Effluent

Liquid effluent would be treated on site using an aerated lagoon system. Flow to the river would be by gravity assisted by pumps and discharge to the river at a point well downstream of the water intake.

3.8.4 Road

A 14 mile road would be constructed from Site #8 to the bridge location at Site #2. As with the other sites a 22 mile road would be constructed from the north end of the bridge to SR 813.

3.8.5 Rail

An 18 mile rail link to Boyle would be constructed to service the site.

3.8.6 Electrical

Construction power is available from the 25 kV Highway 63/Wandering River line which is presently being upgraded from one to three phase power. To tie into the line would require the building of a 5 mile line to the site.

Pumping power would be required to be delivered to the remote water intake on the Athabasca River. This would necessitate the construction of a 7 mile, 3 phase 25 kV line.

Standby power capable of delivering 30 MW during emergencies is available from a 138 kV line south of the site at Highway 55 (11 miles).

3.8.7 Natural Gas

Natural gas is available from the Atmore line located 4 miles away.

3.8.8 Environmental

Land capability for agriculture at Site #8 is rated under the Canada Land Inventory as Class 4 with limitations due to excessive moisture. The potential for ungulate habitation is moderate.

The water quality at the proposed intake is very good. The site from an air quality point of view is only fair due to its proximity to Plamondon and Lac La Biche (lake), which are both located downwind. A pulp mill at this site could also likely be seen from both Plamondon and Lac La Biche.

3.8.9 Socio-Economic

Site #8 located 38 miles from the Town of Athabasca, 30 miles from Lac La Biche, and 29 miles from Boyle. Of all the sites, this site is the most central to the three major communities in the region.

The site is within the Rural Use District (RU) under the County's Land Use Bylaw NO. 10-1987. A pulp mill is a Discretionary Use under this land use district (Natural Resource Extraction).

3.9 SITE #9 (Figure B-9)

Site #9 is located approximately 32 miles downstream of the Town of Athabasca. The site is on the north bank of the river in I.D. #17.

3.9.1 Land

The land at Site #9 in I.D. #17 consists of sand dunes. The soil profile is sand over lacustrine clay over till or bedrock. The elevation of the mill site is 1800 feet above sea level (source: 1:50,000 topo maps). The soils would likely require spread footings on a compacted pad and pile foundations for heavy tanks and equipment. Present land ownership is crown. The site is heavily treed over the north half with sparse vegetation over the southern half which is an old burn area. Considerable site grading would be required due to the rolling topography. The site is narrow and restricted due to the wetlands on the north and the river bank on the south. This creates a situation where little flexibility exists in fixing the location of various mill industrial elements on the site (eg. log storage, plant, effluent ponds, etc.). Also, no existing roads provide immediate access to the site. Therefore, some delay would be experienced during the initial stages of construction while an access road is built to the site. Gravel is available in the Calling Lake area and at Site #1.

3.9.2 Water

Using a river elevation of 1625 feet above sea level, a 175 foot lift of water over a distance of 6000 feet would be required. A 36 inch pipeline with three 800 horsepower pumps would be built to provide raw water to Site #9.

3.9.3 Effluent

Liquid effluent would be treated on site using an aerated lagoon system. Flow to the river would be by gravity alone, to a point well downstream of the water intake.

3.9.4 Road

A road would be required to be constructed 14 miles to Highway 55 along with a 22 mile road to SR 813. A highway bridge across the Athabasca River will be required similar to all other sites, except that it would likely be combined with the rail on one high level bridge structure to achieve economies of scale. A one mile link from the site to the bridge would be required along with an 11 mile wood haul road to Highway 63.

3.9.5 Rail

A 26 mile rail spur would be required to link the site to Boyle. The line may be required to be built to a higher standard if it could be extended to the Wabasca/Desmarais oils sands area in the future. A high level rail/road bridge would be built across the Athabasca River.

3.9.6 Electrical

Construction power is available 12 miles south of the River at Highway 55. A River crossing is required to bring a 3 phase, 25 kV line to Site #9.

Standby power capable of delivering 30 MW during emergencies is available from a 138 kV line near Highway 55 (24 miles).

3.9.7 Natural Gas

Natural gas is available from the NOVA line 6 miles west of the site.

3.9.8 Environmental

Land capability for agriculture at Site #9 is rated under the Canada Land Inventory as Class 6 with soil limitations. The potential for ungulate habitation is good for wintering on the banks of the Athabasca River.

The water quality at Site #9 is good and the site is relatively good from an air quality point of view. The visual impact of a pulp mill development at Site #9 from the communities would be negligible.

3.9.9 Socio-Economic

Site #9 is located 36 miles from Athabasca and 46 miles from Lac La Biche. It is located at the edge of the daily commuting distance from Lac La Biche.

The site is designated for Agriculture Use (A1) under I.D. 17's Land District Map (Land Use Order Order No. 1 - July 29/81). A pulp mill would be a Discretionary Use under the Agriculture District 1 "A1" (Natural Resources Extraction Industry).

3.10 SUMMARY

The initial capital and operating/maintenance costs over 20 years have been estimated for each infrastructure component. The following summarizes the approach which was taken in costing out the various components.

3.10.1 Land

On-site land development costs were estimated to prepare the sites for mill construction. These costs included the following:

- 1) clearing and grubbing
- 2) site grading (stripping/bulk and structural fill)
- 3) granular materials processing
- 4) granular materials hauling
- 5) concrete costs
- 6) . piling costs

No value for land was included in the cost estimates since it was assumed that land costs at all the sites would be about equal. Cultivated farm land in the area currently sells at about \$200-\$250/acre.

3.10.2 Water

For cost estimating purposes, the following assumptions were made for the cost of providing water to each site:

1. All pipelines would be welded steel because of the relatively high operating pressures.
2. 36-inch pipe used in all cases with a velocity of 7.5 feet/second.
3. Assumed pump and motor efficiency @ 70%.
4. Power cost at 5¢ per kWh (blended average of block tariff power rates from Trans Alta Utilities).
5. Pipeline cost at \$300/foot which includes pipeline, valves, air release, installation, road crossings, creek crossings and cathodic protection.

6. Operation and Maintenance:

Pipeline - 1% of capital cost annually

Pumps - 5% of capital cost annually

7. Assumed storage requirements the same at all sites.

3.10.3 Wastewater

The following assumptions were used in calculating the differences in costs between the different sites for the treatment and discharge of liquid wastes:

1. Flow rates the same as water supply when 90% returned plus a 10% allowance for storm waters and/or peak flows.
2. Sites 1, 2, 3, 4 and 9 require no return pump station.
3. Sites 5 and 8 require single unit waterhammer control (@\$200,000) and Sites 6 and 7 require double units.
4. All sites have equal access to clay or suitable sealing material or equivalent costs for bentonite and other liners.

3.10.4 Roads

The cost of building new roads was estimated based upon the following parameters:

1. A highway bridge is required across the Athabasca River at Site #1 or Site #2 in order to transport wood resources from Calling Lake to the mill sites south and east of the Athabasca River.
2. A combined highway/rail bridge across the Athabasca River is required to service Site #9. The prime purpose of the highway crossing is to transport

wood from the south, east and north via Highway 63 to the mill site and to transport employees from Boyle, Plamondon and Lac La Biche.

3. A highway link to SR 813 from the north or west end (Site #1) of the Bridge will be built in all cases.
4. The access roads will be located so as to provide a convenient means to allow daily commuting to the mill from Athabasca, Lac La Biche, Boyle and Plamondon.
5. A connection will be built between Site 2, 3, 4 and 9 and Highway 63 to allow for the transport of wood.
6. Access roads will be built to Alberta Transportation standards RAV-213 at an assumed cost of \$500,000/mile. This standard requires a 2-lane paved highway with 3.5 m lanes and 3.0 m shoulders.
7. No cost allowance is provided for the purchase of any land associated with road allowance or bridge crossings. Existing road allowances are used wherever possible.
8. Differential wood haul costs over 20 years discounted @ 4% are calculated from screen lines defined by the edges of the region. A cost of \$2.00/mile is assumed with 67,000 loads/year.

3.10.5 Rail

The following approach was taken with respect to the provision of rail service to all nine sites:

1. The CNR line at Boyle is considered the only line in the region capable of carrying the industrial rail traffic today and in the future.
2. Use of 115 # rail (part worn) will be used with grades not to exceed 2%.

3. A value of \$1,000,000 per mile has been used for planning estimates. This includes the cost of ballast, ties and rail. An allowance for drainage over terrain typical to that found in the Athabasca/Lac La Biche area is also included in this figure.
4. No allowance has been made in the cost estimates for the purchase of land for the rail right-of-way. However, this cost is minor when compared to the total cost (say 1-3% of total cost).

3.10.6 Electrical

With respect to the electrical needs of the mill, the following is assumed at each site:

1. A 3-phase 25 kV power line will be needed for construction purposes at each site.
2. A 3-phase 25 kV power connection will be required to operate the pumps at the water intake.
3. A 3-phase 138 kV power source must be provided at the mill during operations. The system must be capable of providing 30 MW of stand-by power.

3.10.7 Natural Gas

Natural gas is readily available in the area from a number of transmission lines. In all cases, an allowance has been made for a turbine metering station (\$500,000) and a 6 - 10-inch line could supply the mill sites with gas in sufficient quantities. An assumed value of \$212,000 per km has been used for calculation purposes.

3.10.8 Environmental

No allowance has been made for possible costs associated with mitigative measures. It is assumed that these costs would be equal for each site. These will be estimated later for the prime site as part of the Environmental Impact Assessment required prior to a permit to construct being issued.

3.10.9 Socio-Economic

Costs associated with Socio-economics have been identified as the costs associated with commuting. For simplicity the following assumptions have been made:

1. Operating workforce at the mill is assumed at 330 people.
2. Only the communities of Athabasca, Lac La Biche, Boyle and Plamondon are included in the analysis. In reality other smaller communities and the rural areas will be home to employees at the mill.
3. No allowance has been made for employees and contract employees associated with the forestry operations. This will be equal in all cases and is not dependent upon the mill site location.
4. The mill will operate 345 days per year, with two 12-hour shifts per day with 4 days on with 4 days off.
5. The cost of commuting is assumed to be 45¢ per km. This includes operating/maintenance costs for a private vehicle including depreciation.
6. Mill operating employees were arbitrarily assigned to the four communities in direct proportion to their population and inversely as to their distance from the mill site.
7. No distinction was made between administrative and shift personnel.

3.10.10 Site Comparison

A differential cost comparison was used to compare the sites for infrastructure development. Infrastructure was only considered where a significant difference was expected between sites. Site 2a was chosen as the reference since it was the most economical. This site is defined in Figure 4.

Tables 2, 3 and 4 summarize the results of the economic analysis. For purposes of estimating operating and maintenance costs, 20 years was assumed at a discount interest rate of 4% for the purposes of calculating present value.

From a cost point of view, this analysis shows that the sites located on the south bank of the Athabasca River in the County of Athabasca (Sites 2, 3 & 4) are preferred by quite a large margin over the others. This is due to a couple of factors, namely:

1. Site 1 I.D. #18 and Site 9 I.D. #17, although on the banks of the Athabasca River are either too remote in the case of Site 1 or have to be serviced with a costly road/rail bridge across the Athabasca River in the case of Site 9.
2. The cost savings realized by having to build a shorter rail connection from Boyle to Sites 5, 6, 7 and 8 are far outweighed by the need to transport water in and effluent out of these sites from/to the Athabasca River.

Environmentally, Sites 2 and 3 are preferable to Site 4 due to the fact that they are further from the Town of Athabasca. This is considered important from two points of view: odour problems would be less at Sites 2 and 3 and the water quality should also be better. Also, the visual impact of a mill developed at Site 4 upon the Town of Athabasca is a negative factor compared to Sites 2 and 3.

TABLE 2
DIFFERENTIAL COST COMPARISON BETWEEN NINE SITES
FOR INFRASTRUCTURE DEVELOPMENT
CAPITAL COSTS

Cost Factor	2a (base case)	Differential Cost (\$x millions) - Site								
		1	2	3	4	5	6	7	8	9
Water	--	-0.3	3.7	0.1	0.6	13.6	25.2	39.7	21.0	-0.4
Effluent	--	-0.5	3.4	-0.9	-0.5	15.8	27.6	42.1	23.2	-0.5
Site Preparation/ Granular Materials	--	-2.2	-2.9	-0.1	3.1	0.6	1.0	-0.5	-0.5	0.7
Foundations	--	-1.0	-1.0	-0.9	-1.0	-0.5	-0.5	-0.5	-0.5	0.2
Rail	--	12.6	-0.5	2.6	1.7	-8.0	-12.3	-20.3	-4.6	4.0
Road	--	-14.5	--	2.5	-1.0	-13.5	-13.5	-13.5	-13.5	-7.5
Bridge	--	--	--	--	--	--	--	--	--	22.3
Electrical	--	2.4	-0.6	0.6	-0.6	-0.8	-0.9	-2.6	-0.8	1.7
Natural Gas	--	1.1	-0.2	1.4	1.3	1.8	-0.3	-0.3	0.8	1.4
TOTAL	--	-2.4	1.9	5.3	3.6	9.0	26.3	44.1	25.1	21.9

TABLE 3
DIFFERENTIAL COST COMPARISON BETWEEN NINE SITES
FOR INFRASTRUCTURE DEVELOPMENT
OPERATING/MAINTENANCE COSTS

Cost Factor	2a	Differential Cost (\$x millions) - Site								
		1	2	3	4	5	6	7	8	9
Water	--	1.8	6.0	5.8	6.1	13.5	20.3	31.4	14.9	0.8
Effluent	--	-0.1	0.5	-0.1	-0.1	10.4	17.2	25.5	14.6	0.5
Rail	--	4.6	--	--	--	-4.6	-5.3	-8.8	2.3	1.4
Wood Haul	--	-8.0	1.0	5.0	14.0	21.0	12.0	25.0	-4.0	1.0
Commuting	--	32.5	-3.3	-1.4	-13.9	-24.1	-18.8	-38.1	-4.3	5.8
	--									
TOTAL	--	30.8	4.2	9.3	6.1	16.2	25.4	35.0	23.5	9.5

TABLE 4
DIFFERENTIAL COST COMPARISON BETWEEN NINE SITES
FOR INFRASTRUCTURE DEVELOPMENT
CAPITAL AND OPERATING/MAINTENANCE COSTS

Cost Factor	Differential Cost (\$x millions) - Site									
	2a	1	2	3	4	5	6	7	8	9
Capital	--	-2.4	1.9	5.3	3.6	9.0	26.3	44.1	25.1	21.9
O&M	--	30.8	4.2	9.3	6.1	16.2	25.4	35.0	23.5	9.5
	--	—	—	—	—	—	—	—	—	—
TOTAL	--	28.4	6.1	14.6	9.7	25.2	51.7	79.1	48.6	31.4

Socio-economically, Site 2 is well within the daily commuting distance from all four communities within the region: Athabasca, Lac La Biche, Boyle and Plamondon. The impact upon the Town of Athabasca would be considerable at Site 4 and less so at Site 3.

Therefore, all things considered, Site 2 or 2A is the preferred site for the development of a pulp mill for a number of reasons, namely:

1. It is the most economical to develop.
2. It is approximately midway between Athabasca and Lac La Biche.
3. The site is located on relatively poor agricultural soils.
4. The site is not located upwind of a major urban centre.
5. A local source of granular materials is available.
6. The impact on neighbouring residents is minimized due to the existence of crown land reserves.

Based upon the site evaluation represented in Section 3.0, Sites 2 and 2A are favoured over the other sites from a capital and O&M differential cost point of view. In addition, certain potential economic incentives for development in I.D #17 may be available through the Federal government. The only site in this general area which is in I.D #17 is Site #9. Site #9 is located directly across the Athabasca River from Site 2A and exhibits similar locational advantages with the exception of the cost of providing rail service across the Athabasca River. Therefore, Site 2, 2A and 9 have been evaluated in further detail to establish an "address" for the development of a pulp mill.

4.1 SITE 2 (Figure 3)

Site 2 can be described as the S½ of Section 32 and all of Section 29, Township 68, Range 19 West of the 4th Meridian in the County of Athabasca. This site contains 390 ha (960 acres) and is of sufficient area to accommodate the wood/chip storage, mill, effluent treatment, and solid waste disposal site. The site is expandable in a southerly direction should additional lands be required for a newsprint machine. Additional lands to allow for a buffer will likely be required in addition to lands reserved for future expansion. This will also allow for the purchase of complete farming units where the mill site severs present ownership patterns. A natural buffer exists west and north east of the mill site. Therefore, in total the mill site at Site 2 including land for expansion and ½ mile buffer amounts to some 1620 ha (4000 acres).

The mill location within Site 2 contains a relatively thin layer of gravel overlying a till. These soils made excellent foundation conditions and serves a supply of gravel on site. The Spruce Valley Road provides good road access to the site from Highway 55 east. In addition, a more direct route to the Town of Athabasca is available through Prosperity and Amber Valley. A Nova gas pipeline (406 mm O.D.) traverses the site and contains sufficient volumes of gas to supply the mill's requirements. The pipeline right-of-way proceeds from the site in a northwesterly direction and crosses the Athabasca River at Section 7 Tp

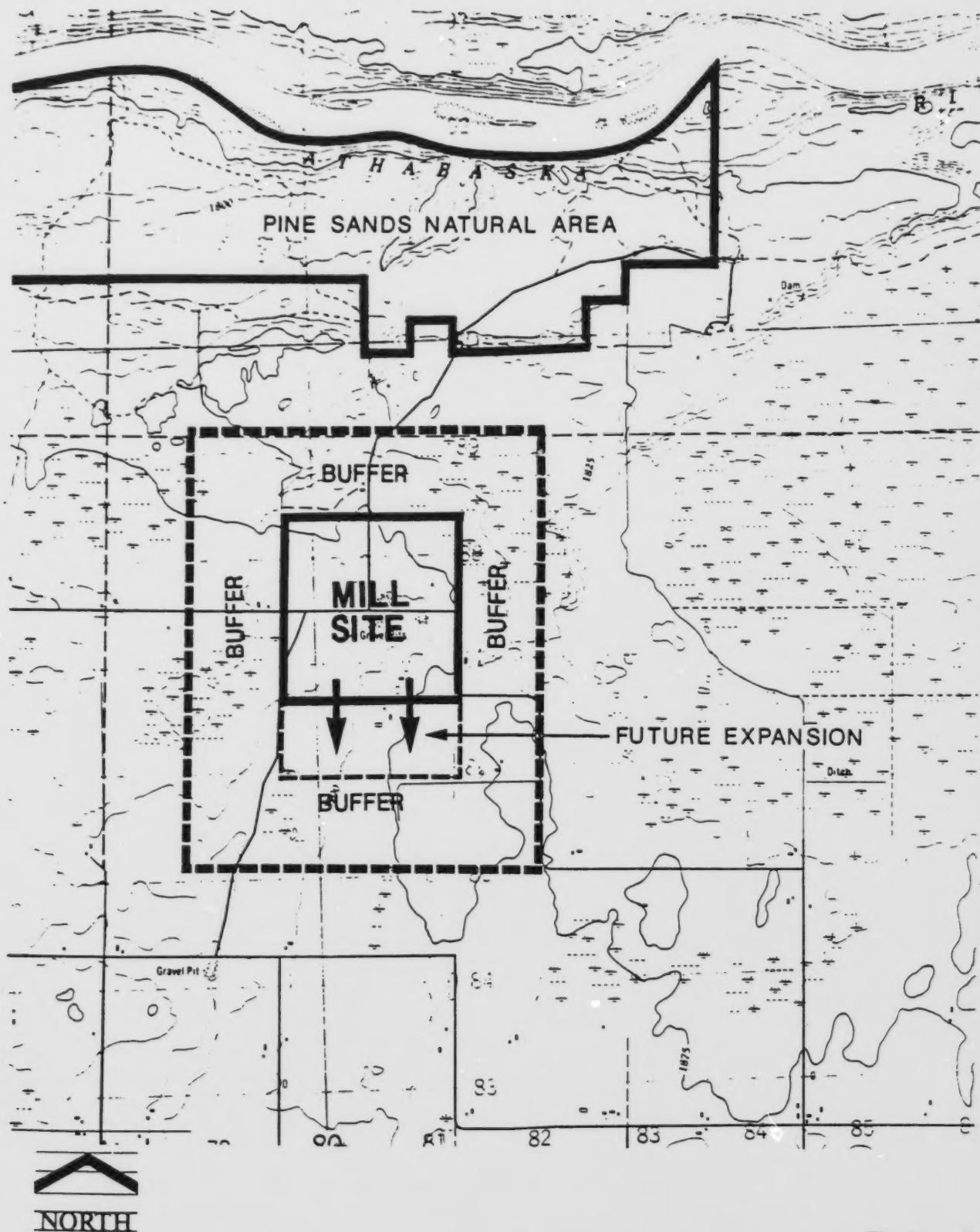


Figure 3



CRESTBROOK FOREST INDUSTRIES
INDUSTRIAL FOREST DEVELOPMENT

SITE 2
LOCATION PLAN

69 R19 W4th. It is proposed that the water intake be located here and water pumped from the river to Site 2 along this right-of-way. Over the first mile back from the river the pipeline passes through the Pine Sands Natural Area. This natural area (1350 ha) was established under Alberta Regulations 47/85 and amended by Alberta Regulations 80/87 under Section 12.1 of the Wilderness Areas, Ecological Reserves and Natural Areas Act. Site 2 is located 1 to 1½ miles south of the Natural area.

4.2 SITE 2A (Figure 4)

Site 2A is more irregular and restrictive in shape than Site 2 or Site 9. The site contains 390 ha (960 acres) and includes developable lands in the S½ Section 4, W½ Section 3, pt NE¼ Section 3, SE¼ Section 10, pt SW¼ Section 11; all in TWP 69 R19 W4th. The site is buffered naturally by the Natural Area and the Athabasca River to the north and a small unnamed creek and muskeg to the south and east. Allowing for an additional four ¼ sections for buffer on the west end of the site, a total of 650 ha (1600 acres) would be required to assemble Site 2A.

The soils in this area support relatively good agricultural crops at the surface and are underlain by sands, clay, and bedrock. These engineering soils over this site are not as good as Site 2 for foundation purposes. As with Site 2A, the Spruce Valley road provides access to Highway 55 for connections east to Lac La Biche.

4.3 SITE 9 (Figure 5)

Site 9 is located on the north side of the Athabasca River in ID 17. The site is located on top of the banks of the Athabasca River in parts of Sections 13, 14, 23 & 24 of TWP 69 R19 W4th. The site is buffered naturally to the north with muskeg and to the south by the Athabasca River. A ½ mile buffer to the east and west of the mill site would result in a total site area of 650 ha (1600 acres). The southern half of the site consists of sandy soils in an old burn area with

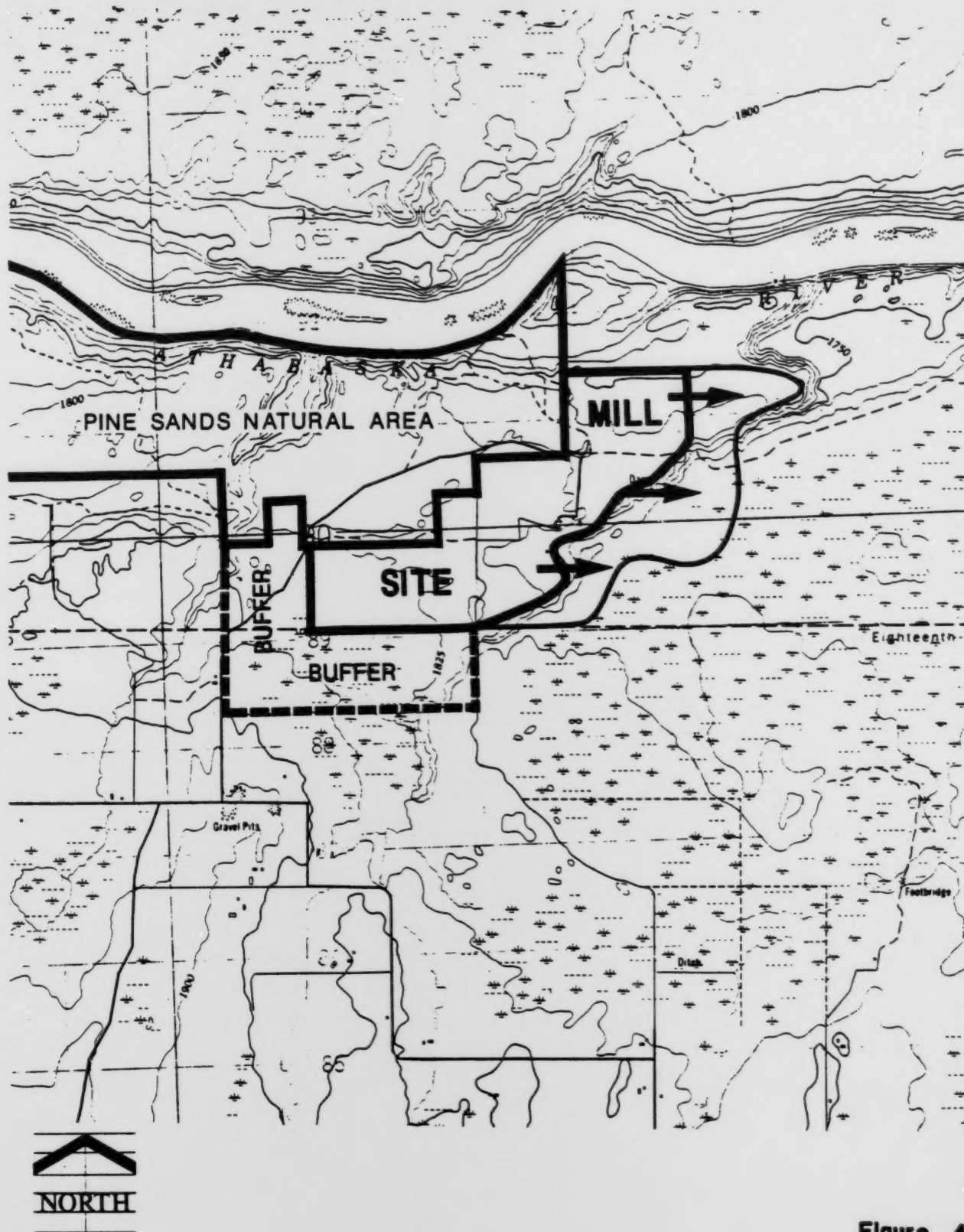


Figure 4



CRESTBROOK FOREST INDUSTRIES
INDUSTRIAL FOREST DEVELOPMENT

SITE 2A
LOCATION PLAN

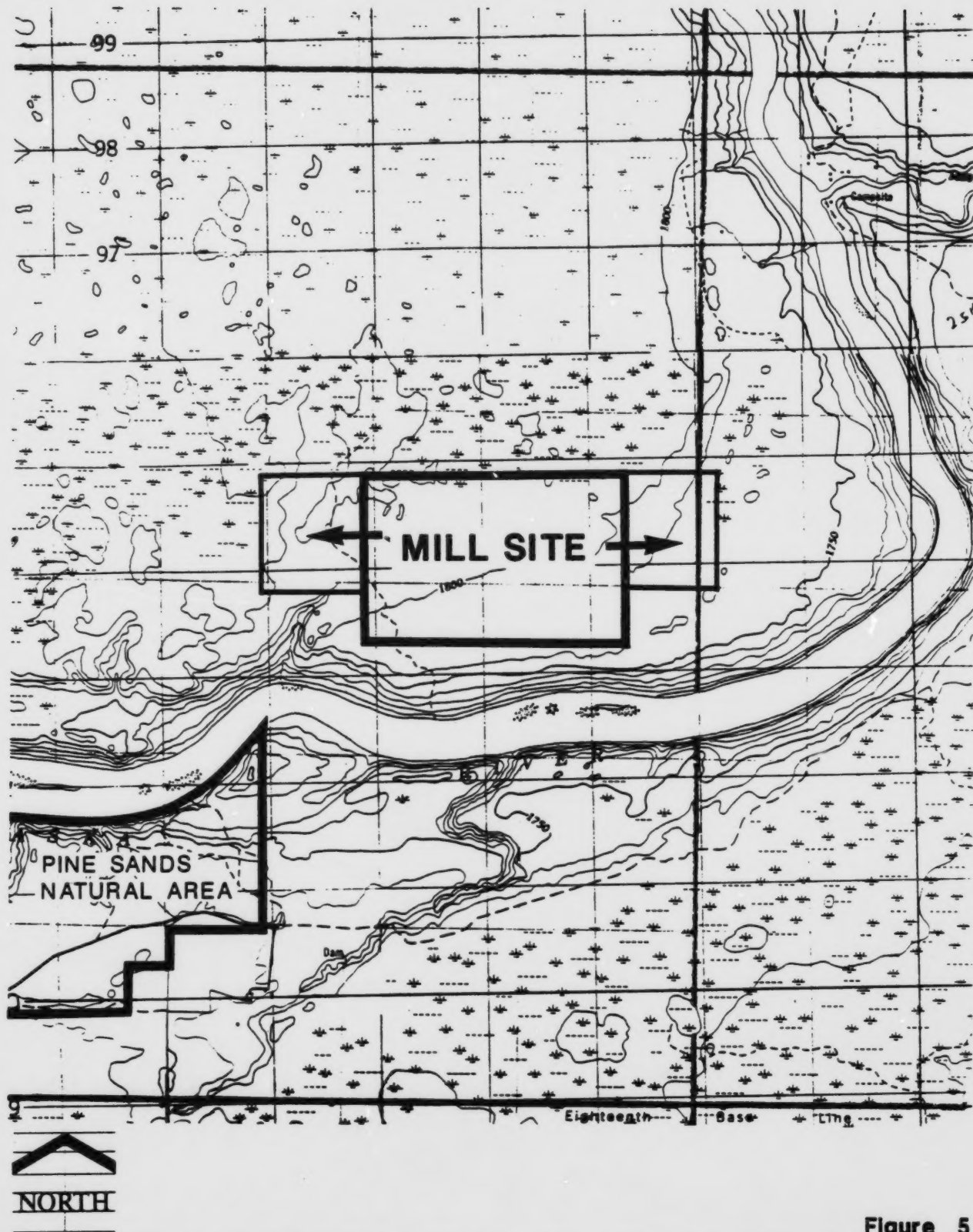


Figure 5



CRESTBROOK FOREST INDUSTRIES
INDUSTRIAL FOREST DEVELOPMENT

SITE 9

LOCATION PLAN

sparse, mature jack pines and young poplar trees. The northern half of the site consists of mature aspen over sandy soils. As with Site 2A, the site is confined and therefore restricted as an industrial development site.

4.4 TRANSPORTATION CORRIDORS/BRIDGE CROSSINGS

4.4.1 Site 2/2A (Figure 6)

Site 2 & 2A would be served by a transportation corridor consisting of a highway extension of Highway 55/63 north through Spruce Valley to the sites. A rail spur from Boyle would be constructed north of Boyle to the sites. The rail route would likely follow the $\frac{1}{2}$ section line, $\frac{1}{2}$ mile east of Highway 63 to a point north of the southern Highway 55 & 63 intersection. The rail would then cross Highway 55/63 at this point and proceed north on the $\frac{1}{2}$ section line, $\frac{1}{2}$ mile west of Highway 55/63 and the upgraded Spruce Valley road. The terrain over which the rail line would be built is rolling with soils varying from muskeg near Flat Lake to a hard till at Boyle and Spruce Valley. Sandier soils are encountered at Site 2 and 2A. The rail would end at both sites; whereas the highway would extend north across the Athabasca River on a low level bridge. A highway link would also be built from the north side of the bridge to SR 813.

There will likely be pressure to provide a more direct road link between the Town of Athabasca and Sites 2/2A. A route from Amber Valley through to Prosperity and on to Site 2/2A would be a logical corridor to develop. Such a route would save some 7 miles for Site 2 and 5 miles for Site 2A. Stated another way, the Spruce Valley route would be 25% longer for Site 2 and 17% longer in the case of Site 2A. This may form part of a development agreement which must be negotiated and signed with the County of Athabasca prior to a development permit being issued.

TO S.R. 813

ATHABASCA

RIVER

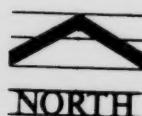
SITE 2

Lumber Reloading
Facility

● SPRUCE VALLEY

- Access Road
- + + + + Rail Access From Boyle
- - - Site Boundaries
- - - Water Supply Line
- Effluent Line

● PROSPERITY



GRASSLAND

55

TO PLAMONDON/
LAC LA BICHE

TO BOYLE/ATHABASCA

Figure 6



CRESTBROOK FOREST INDUSTRIES
INDUSTRIAL FOREST DEVELOPMENT
TRANSPORTATION CORRIDOR
SITE 2

4.4.2 Site 9 (Figure 7)

The major highway corridors into and out of Site 9 would be the same as those for Sites 2/2A, ie Spruce Valley and the connector to SR 813. However, the highway and rail spur from Boyle would cross the Athabasca River on a combined rail/highway bridge. There would not likely be a requirement for a second highway corridor through Prosperity. SR 813 would be used by employees living in Athabasca to travel to the site.

4.4.3 Athabasca River Bridge Crossings

A low level highway bridge crossing of the Athabasca River would be required to service Sites 2/2A. This crossing would allow for the transport of 40% of the wood supply to the mill from the Calling Lake area. Also, employees at the mill living in the Athabasca/Calling Lake area would commute to the mill via this route. The banks of the Athabasca River in the vicinity of Site 2 & 9 are relatively stable with bedrock close to the surface. The approximate location for a low level crossing is shown in Figure 8 allowing for a span of 400 metres, a cost to construct such a bridge would likely be in the range of \$5 - 6 million (Class 10 estimate).

A high level combined bridge (rail/highway) would be required to be constructed across the Athabasca River to service Site 9. The approximate location for such a bridge crossing is shown in Figure 9. The bridge would take about 24 months to construct and a 770 m span structure would likely cost in the vicinity of \$27 million (Class 10 estimate). This would severely impact upon the construction schedule, particularly if any delays were encountered during the construction of the bridge due to unforeseen circumstances. Also, most heavy equipment would be required to be transported to the site by truck, thereby adding to the cost.

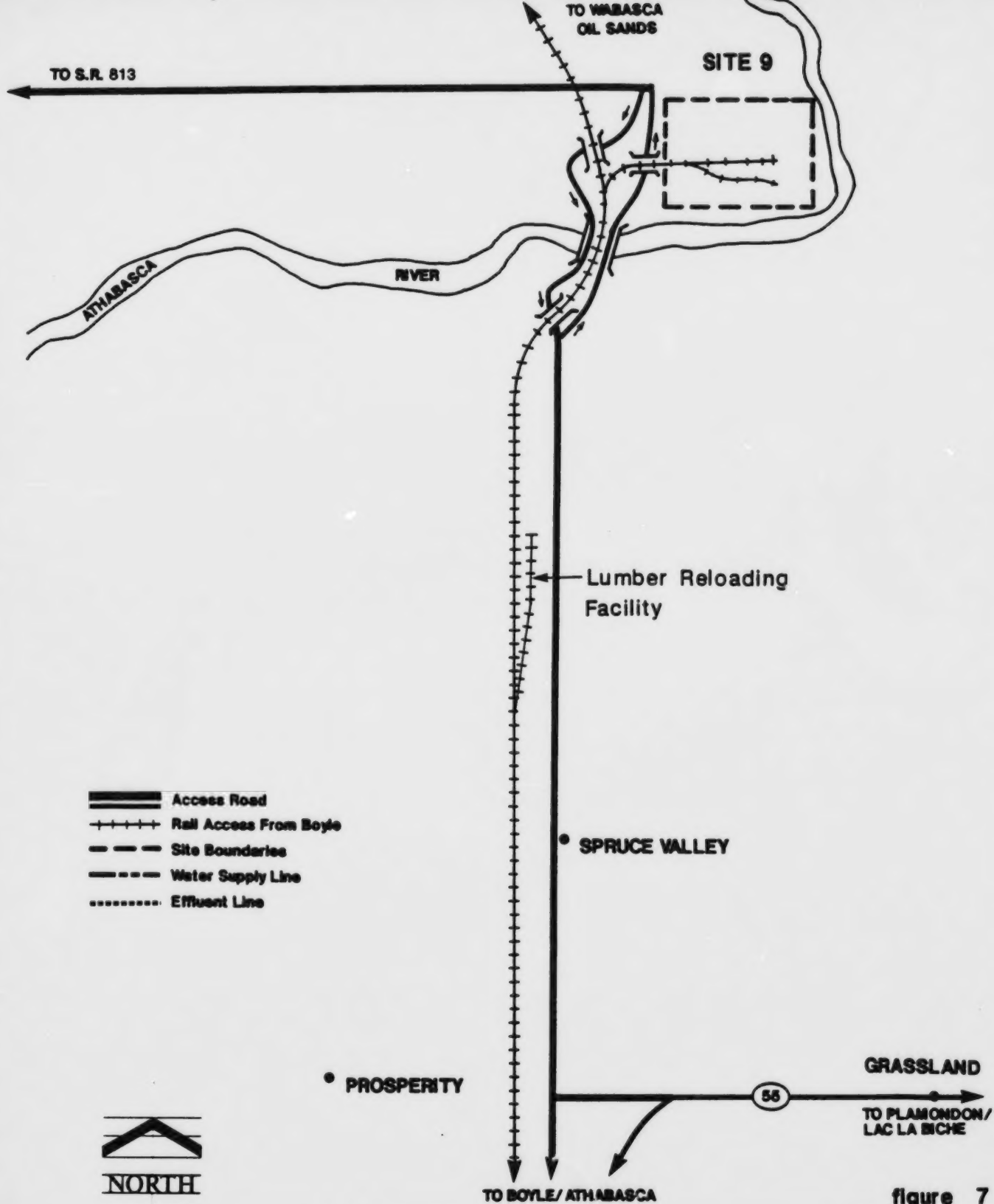


figure 7



CRESTBROOK FOREST INDUSTRIES
INDUSTRIAL FOREST DEVELOPMENT
TRANSPORTATION CORRIDOR
SITE 9

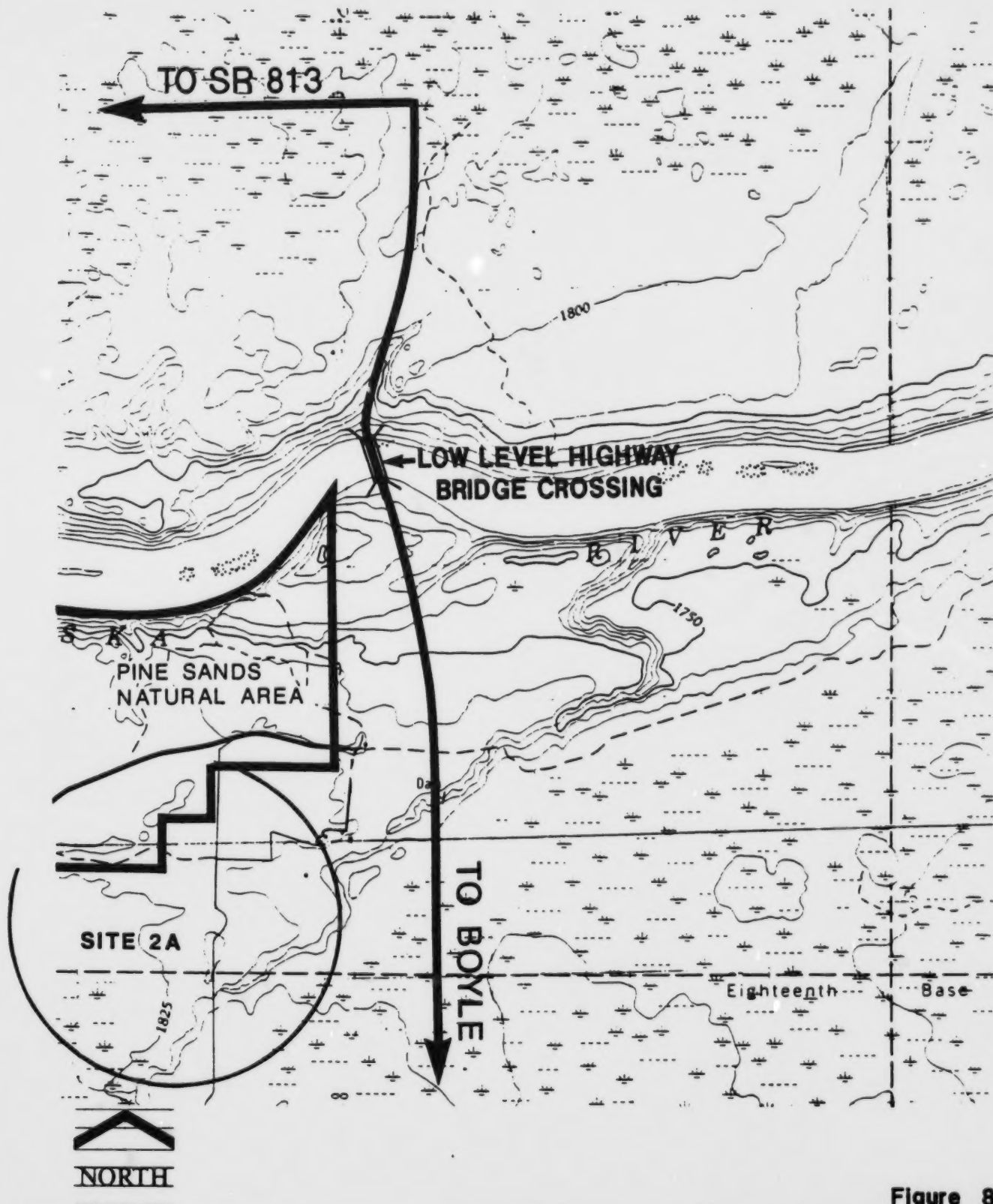


Figure 8



CRESTBROOK FOREST INDUSTRIES
INDUSTRIAL FOREST DEVELOPMENT

SITE 2/2A

BRIDGE CROSSING LOCATION

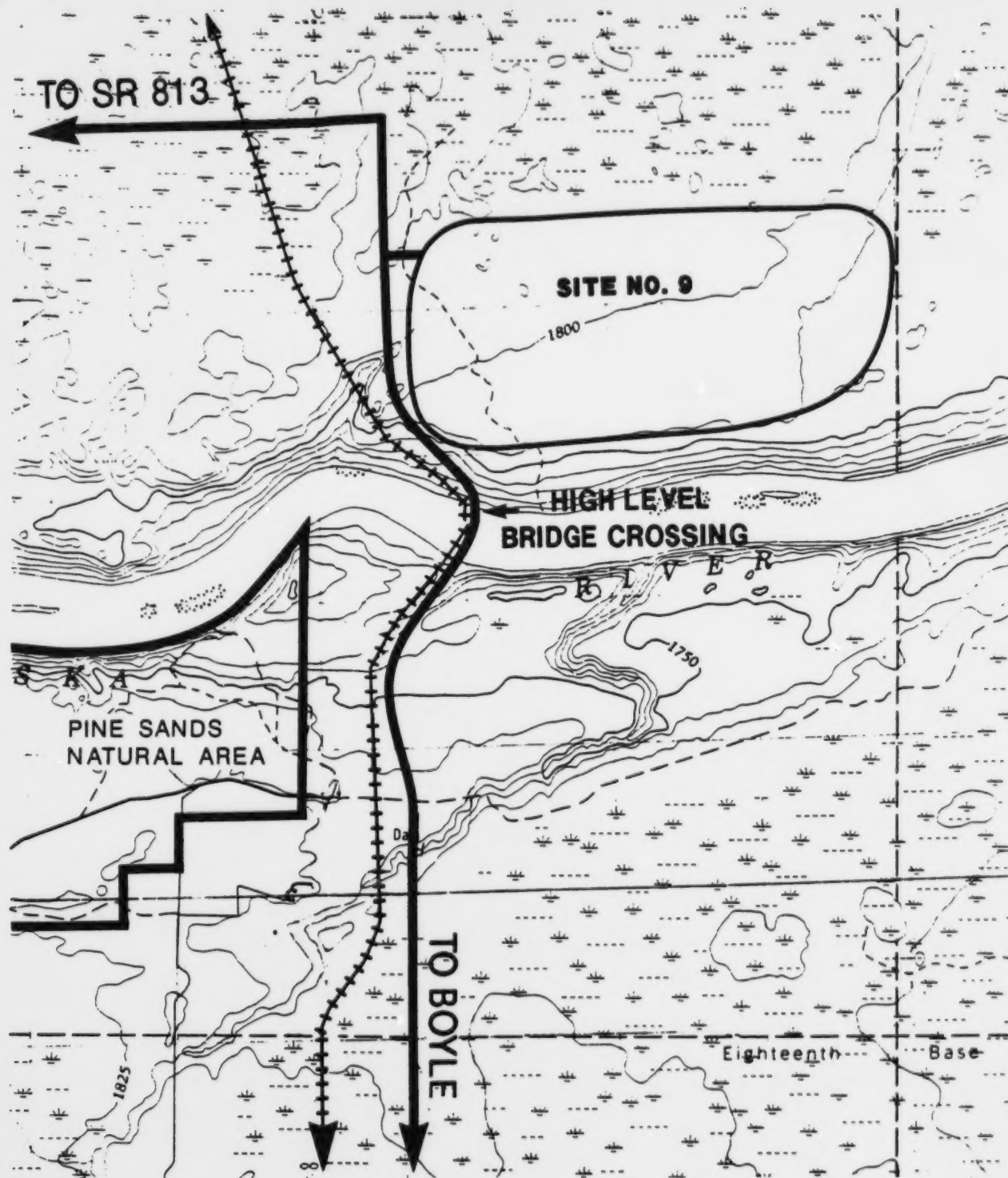


Figure 9

CRESTBROOK FOREST INDUSTRIES
INDUSTRIAL FOREST DEVELOPMENT

SITE 9
BRIDGE CROSSING LOCATION



4.5 SUMMARY

The differential cost comparison between the three prime sites is given below:

DIFFERENTIAL COST (\$ x MILLIONS) - SITE

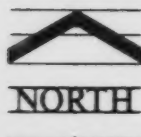
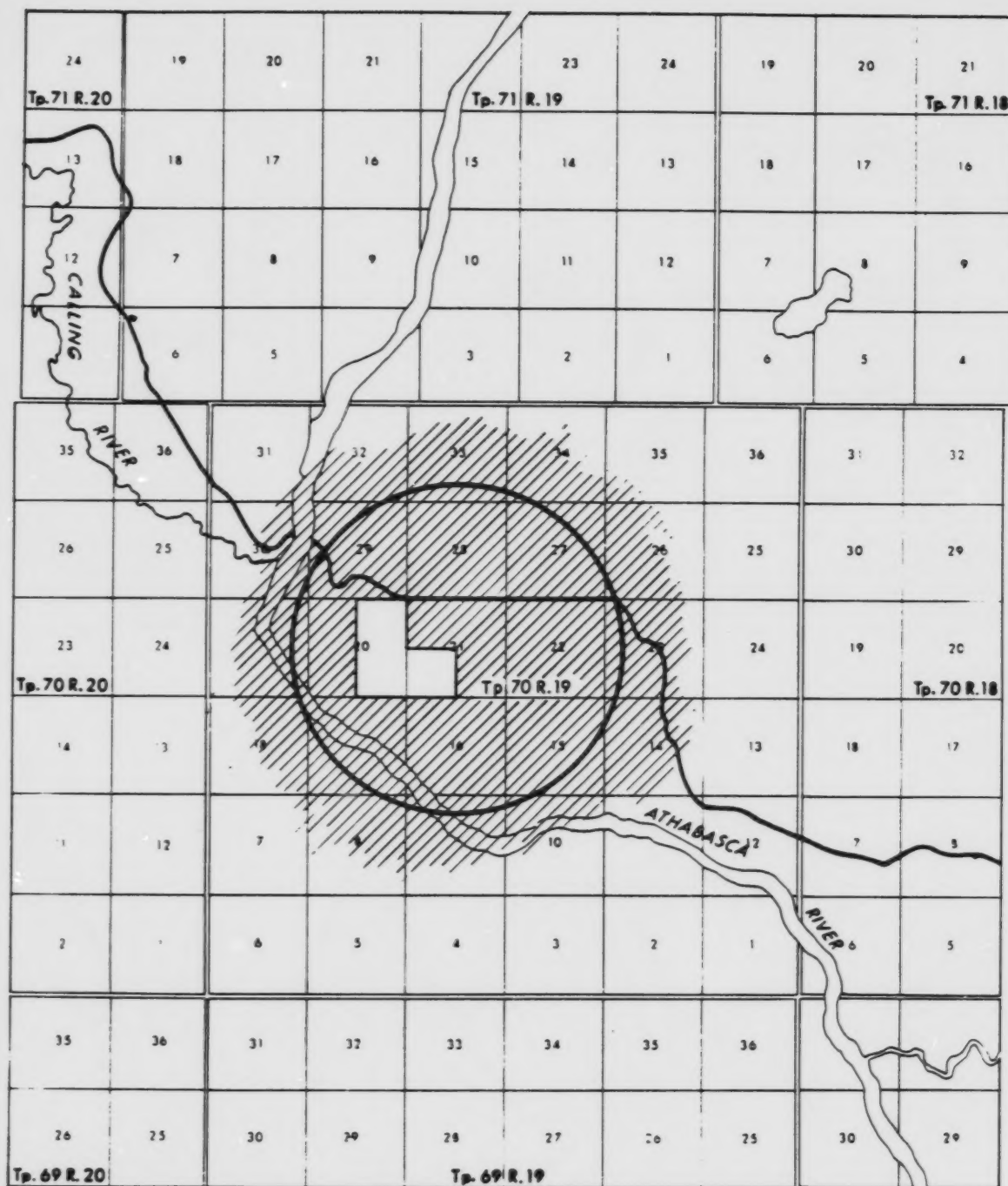
<u>Cost Factor</u>	<u>2</u>	<u>2A</u>	<u>9</u>
CAPITAL COST			
o WATER	3.7	-	-0.4
o EFFLUENT	3.4	-	-0.5
o SITE PREP	-2.9	-	0.7
o FOUNDATIONS	-1.0	-	0.2
o RAIL	-0.5	-	4.0
o ROAD	-	-	-7.5
o BRIDGE	-	-	22.3
o ELECTRICAL	-0.6	-	1.7
o NATURAL GAS	-0.2	-	1.4
SUB-TOTAL	1.9	-	21.9
O & M COST (20 years)			
o WATER	6.0	-	0.8
o EFFLUENT	0.5	-	0.5
o RAIL	-	-	1.4
o WOOD HALL	1.0	-	1.0
o COMMUTING	-3.3	-	5.8
SUB-TOTAL	4.2	-	9.5
GRAND TOTAL	6.1	-	31.4

Site 2A is the least expensive site to develop primarily due to its closer proximity to the Athabasca River than Site 2 (and is 100 feet lower in elevation), and due to the fact that the rail does not have to be extended across the Athabasca River (as is the case with Site 9). However, Site 2A does have some limitations from a development point of view and these are summarized below:

- 1) The site encompasses significant amounts of Class 3 agricultural land.
- 2) The site is directly adjacent to the Pine Sands Natural area.
- 3) The site does not lend itself to flexibility in locating various industrial elements on the site (eg. log storage, mill and effluent treatment), nor is there sufficient surrounding land to allow for future expansion.
- 4) The sandy nature of the soils will require considerable site preparation (grading, granular materials, etc.) and will require pile foundations for tanks and major equipment.
- 5) Operational efficiencies at the mill may not be achievable due to the lack of flexibility inherent in the shape of the site.

Site 9 is much more expensive to develop due to its relatively remote location on the north side of the Athabasca River. This is reflected in the increased costs relative to Sites 2/2A for the bridge, rail and additional commuting costs. Also the sandy nature of the soils present similar development limitations to those at Site 2A. Other costs to develop Site 9 which have not been quantified include any delays caused during construction due to building an access road plus any increases in cost due to the delivery of heavy equipment by road rather than rail.

APPENDIX A
GENERAL LOCATION OF SITES



CROWN LAND

Figure B-1



CRESTBROOK FOREST INDUSTRIES
INDUSTRIAL FOREST DEVELOPMENT

SITE No. 1
GENERAL LOCATION

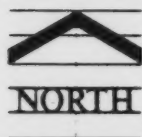
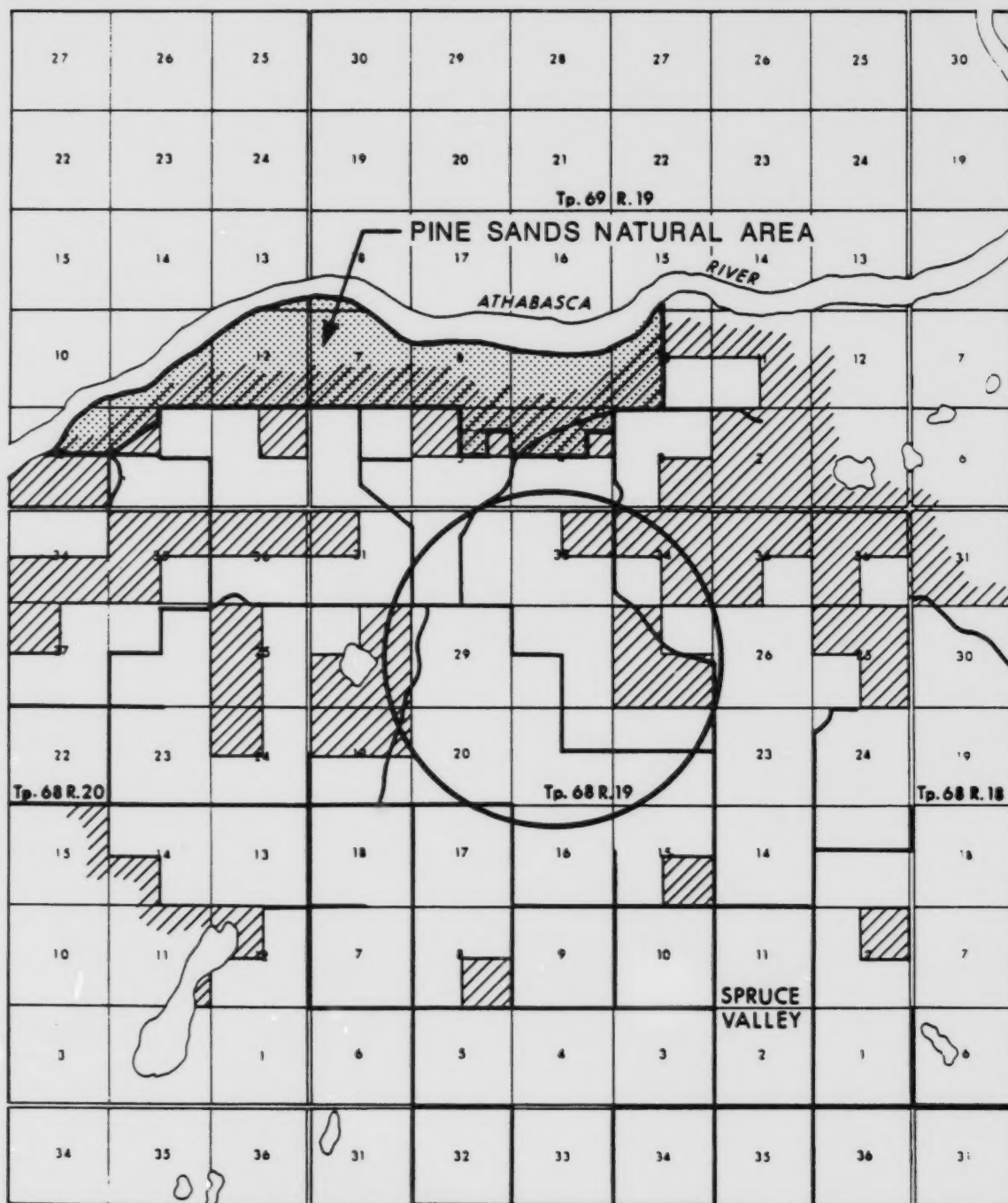


Figure B-2



CRESTBROOK FOREST INDUSTRIES
INDUSTRIAL FOREST DEVELOPMENT

SITE No. 2
GENERAL LOCATION

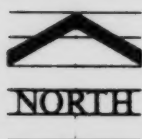
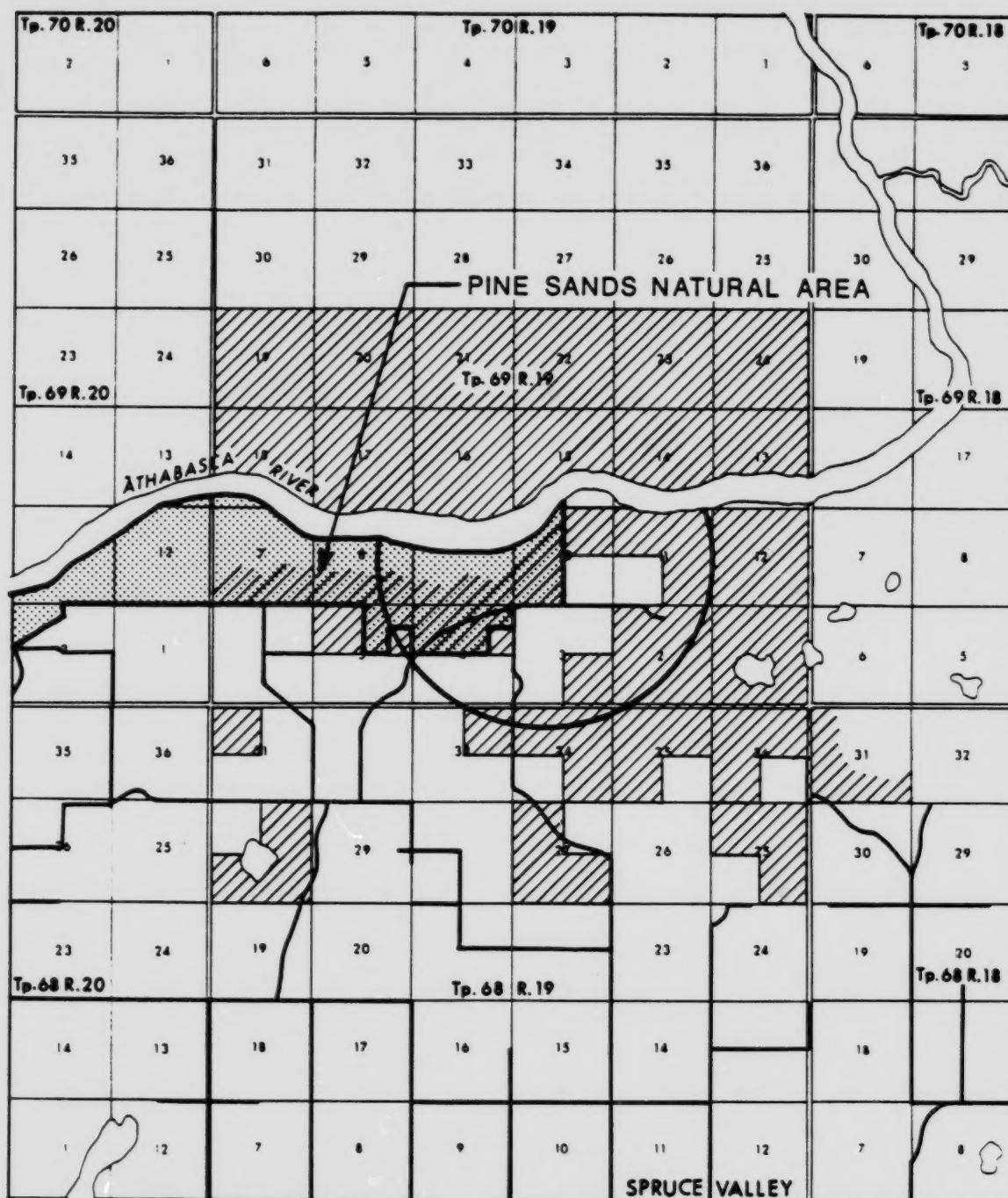
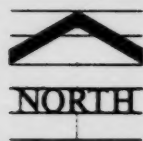
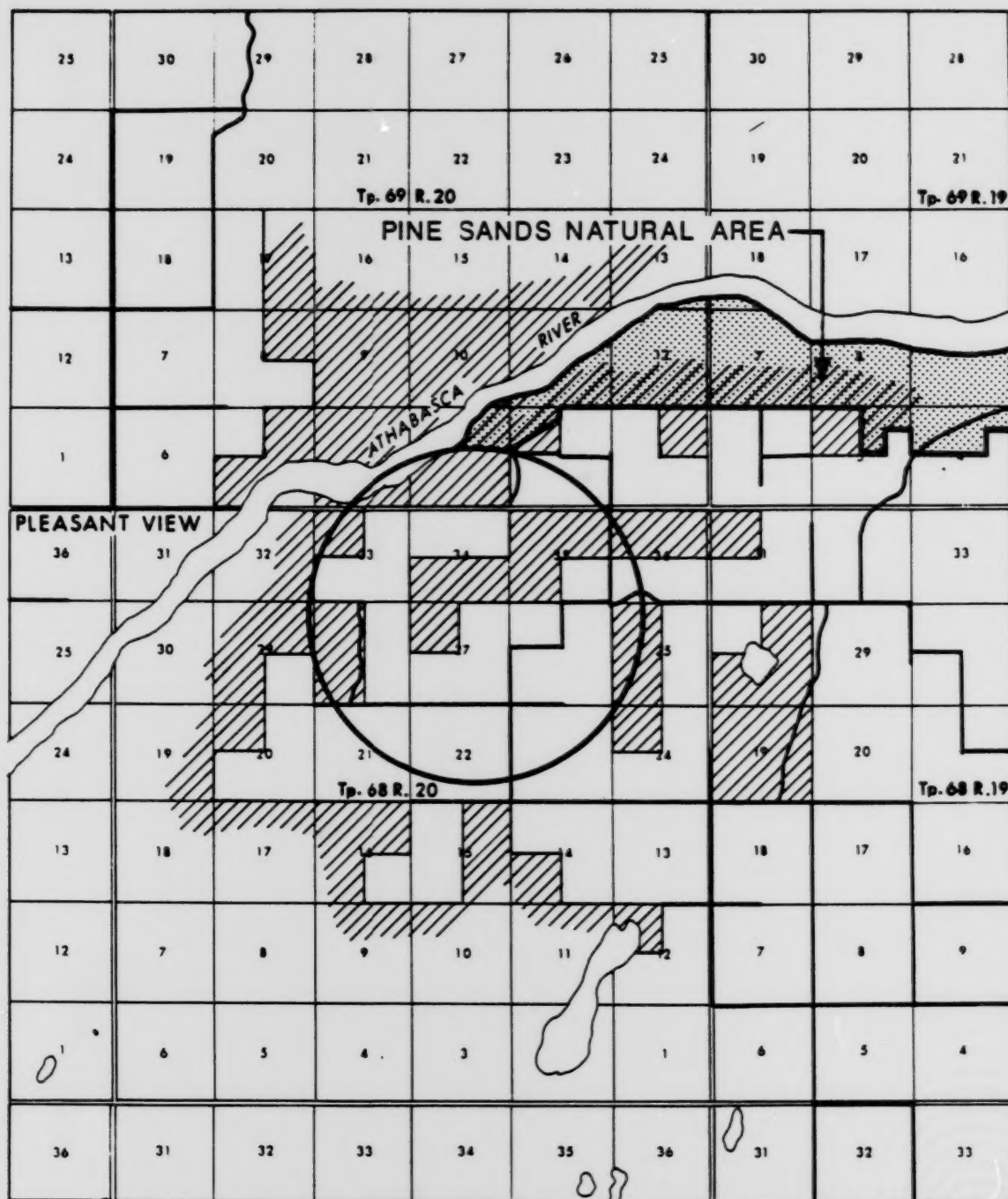


Figure B-2a



CRESTBROOK FOREST INDUSTRIES
INDUSTRIAL FOREST DEVELOPMENT

SITE No. 2A
GENERAL LOCATION



CROWN LAND

Figure B-3



CRESTBROOK FOREST INDUSTRIES
INDUSTRIAL FOREST DEVELOPMENT

SITE No. 3

GENERAL LOCATION

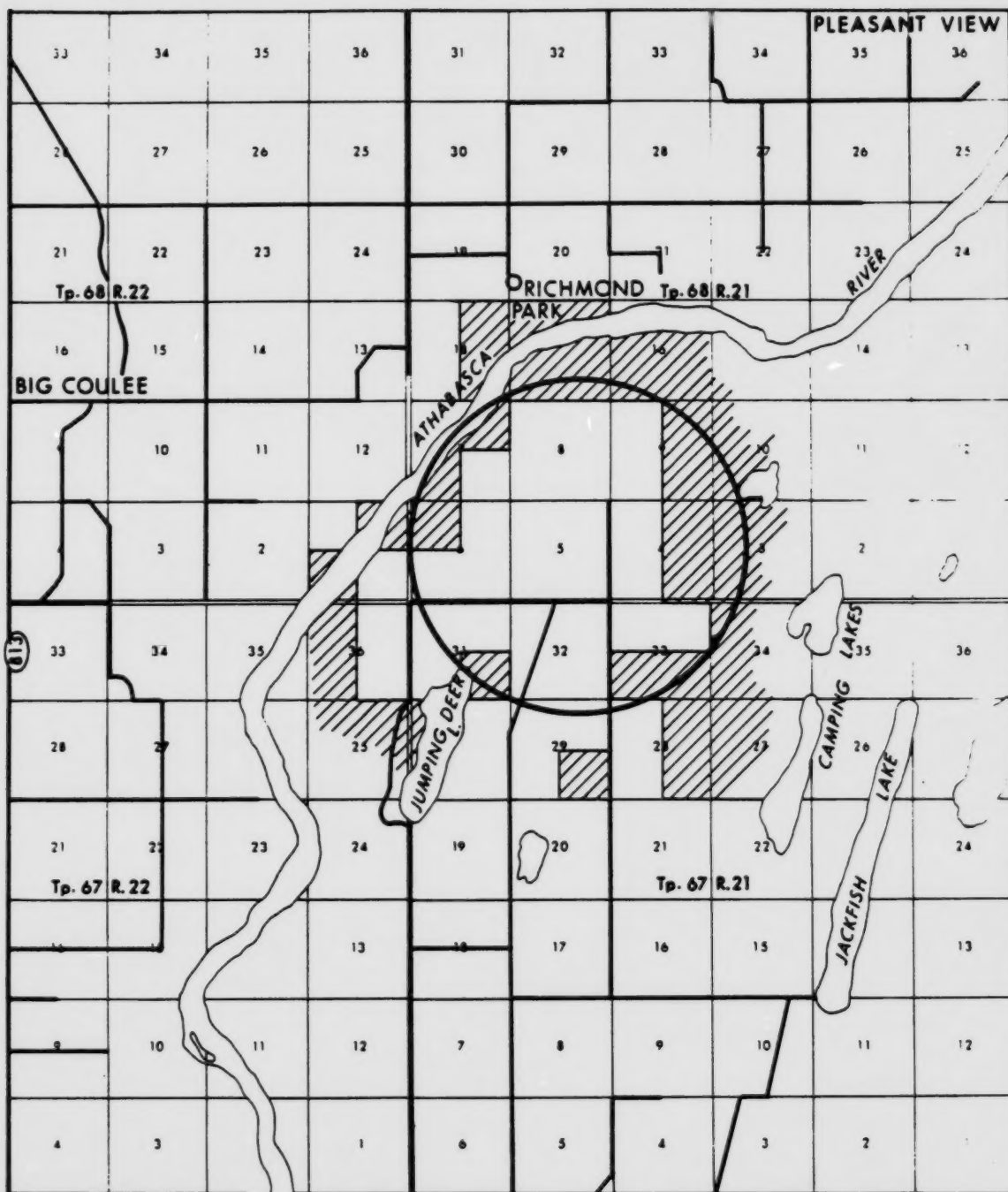
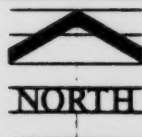
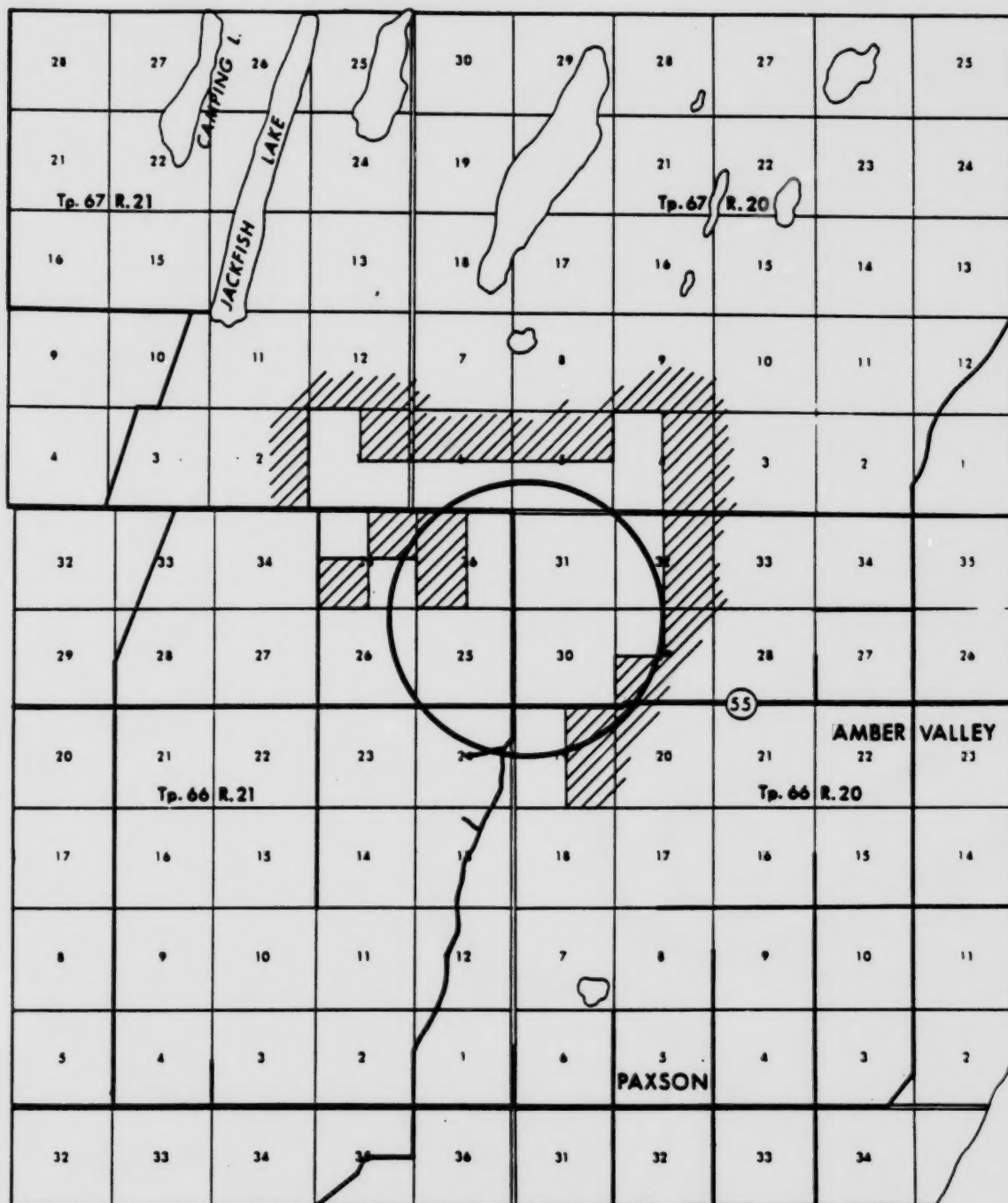


Figure B-4



CRESTBROOK FOREST INDUSTRIES
INDUSTRIAL FOREST DEVELOPMENT

SITE No. 4
GENERAL LOCATION



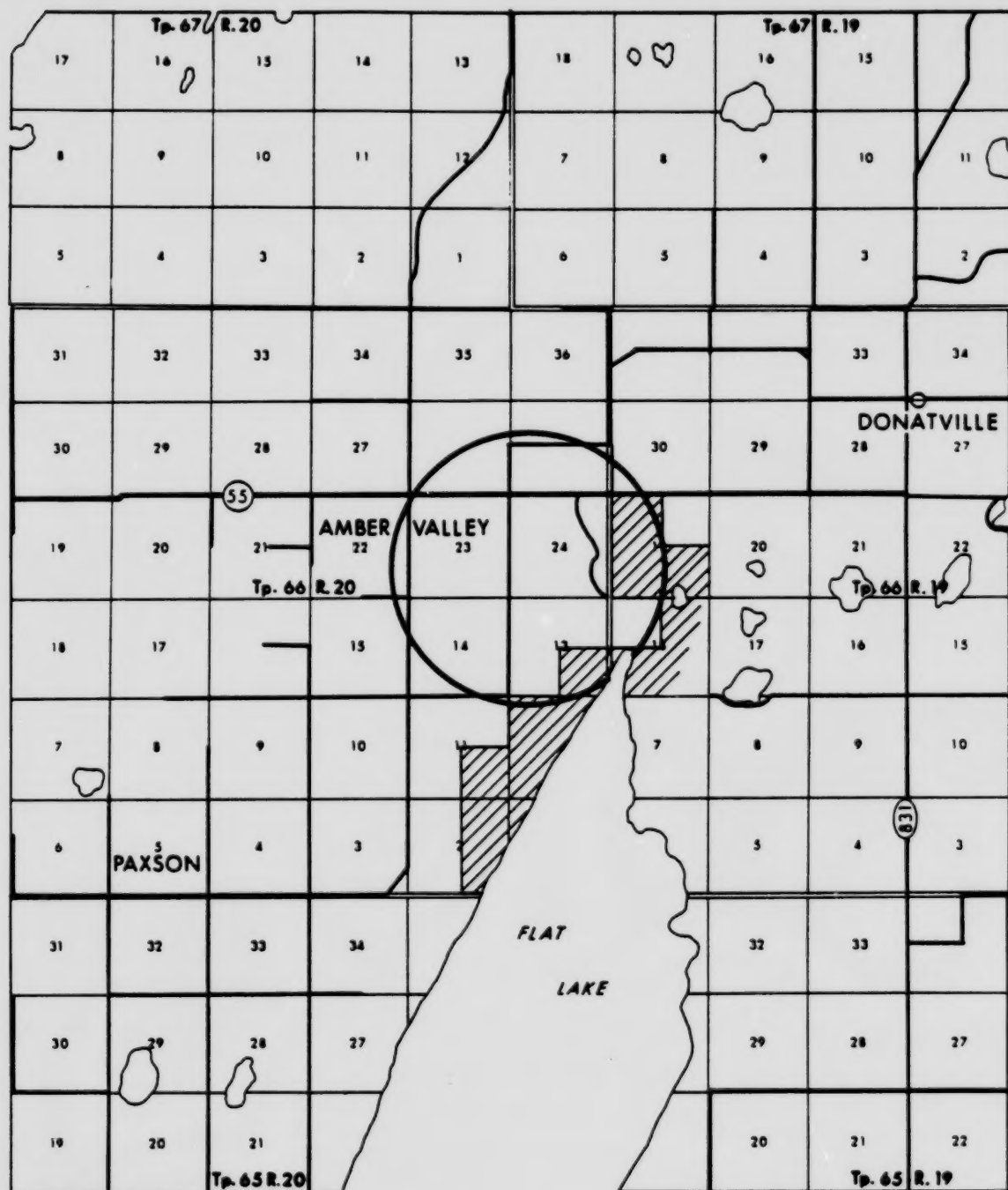
CROWN LAND

Figure B-5



CRESTBROOK FOREST INDUSTRIES
INDUSTRIAL FOREST DEVELOPMENT

SITE No. 5
GENERAL LOCATION



CROWN LAND

Figure B-6



CRESTBROOK FOREST INDUSTRIES
INDUSTRIAL FOREST DEVELOPMENT

SITE No. 6
GENERAL LOCATION

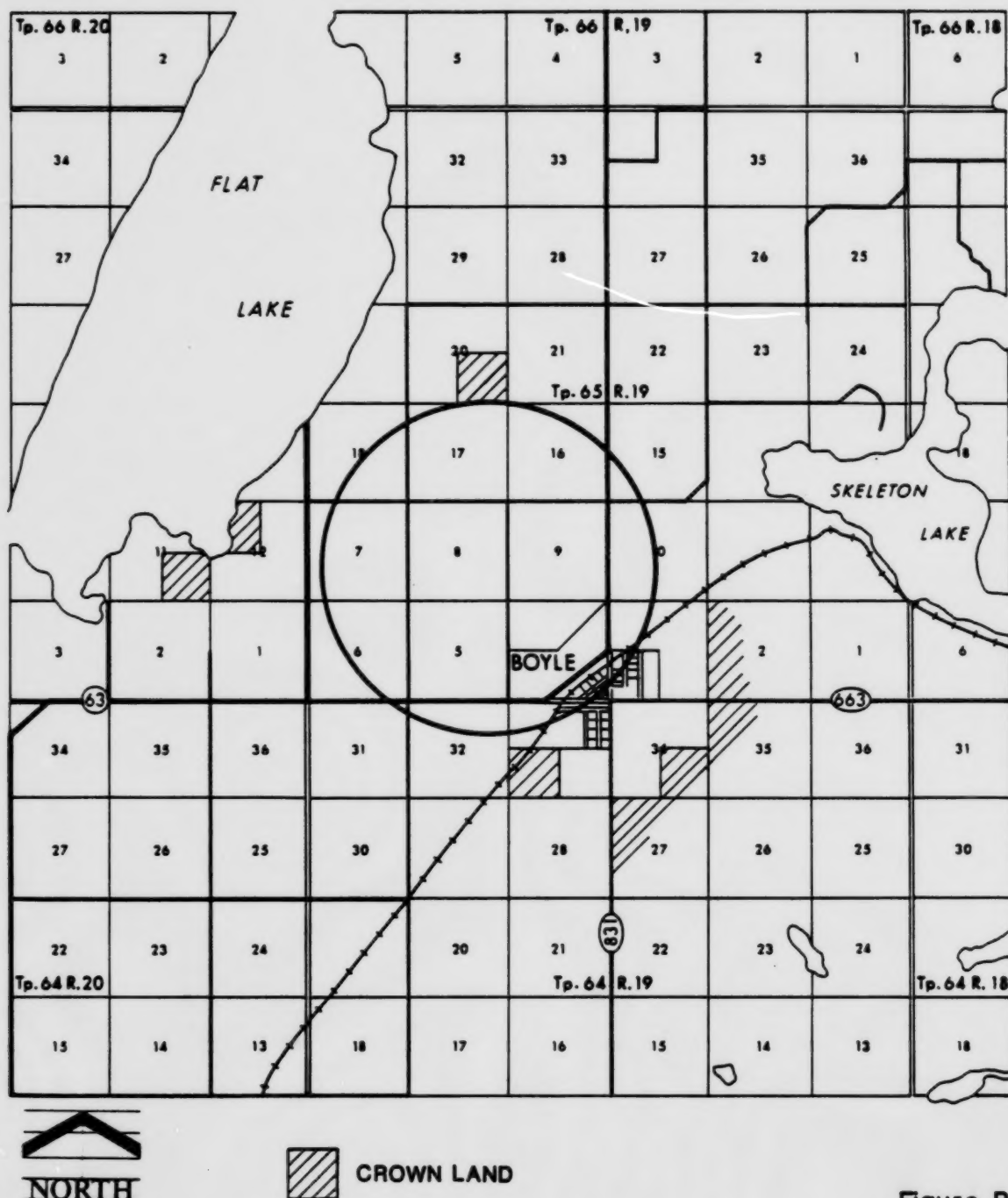


Figure B-7



CRESTBROOK FOREST INDUSTRIES
INDUSTRIAL FOREST DEVELOPMENT

SITE No. 7
GENERAL LOCATION

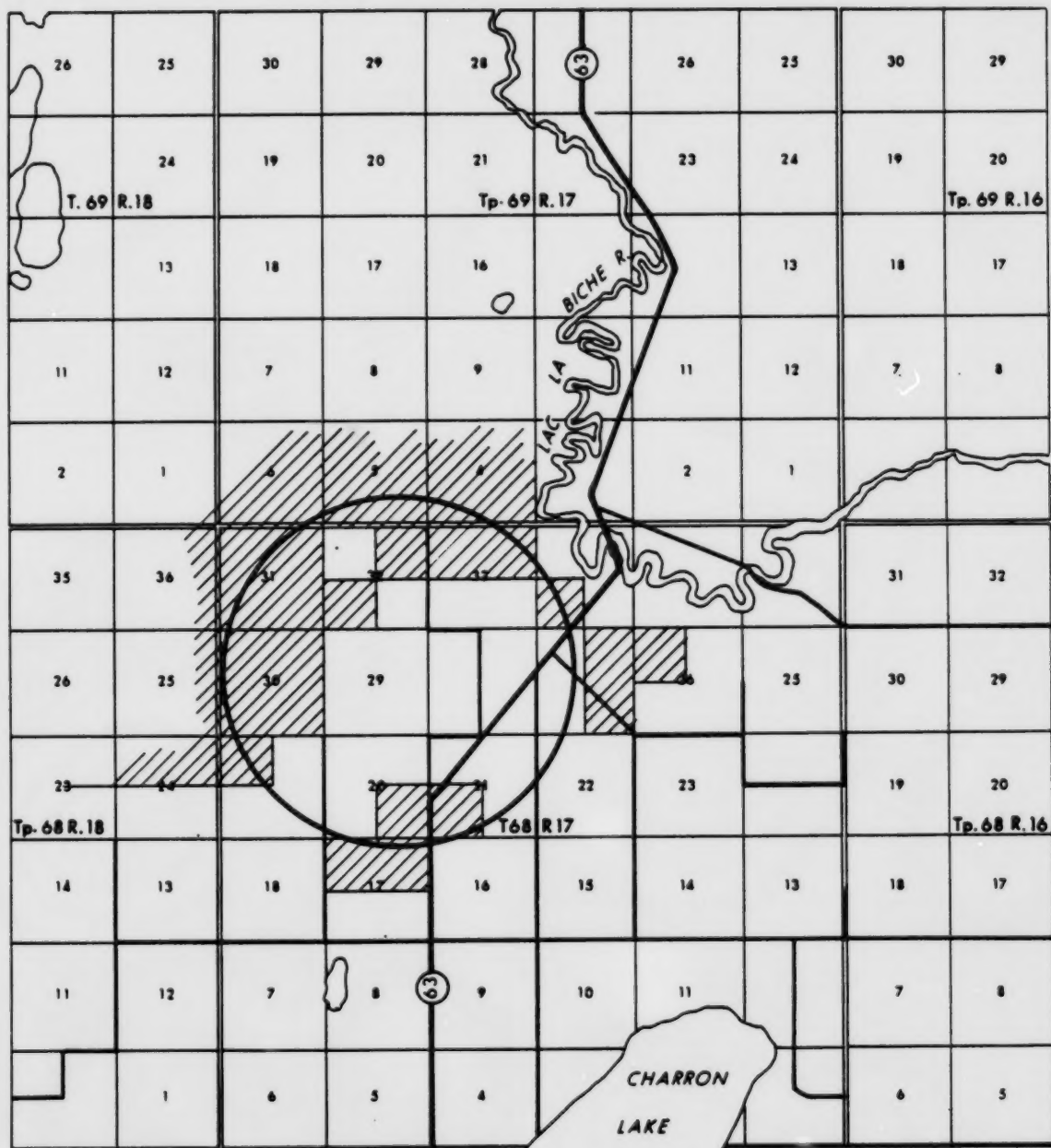


Figure B-8



CRESTBROOK FOREST INDUSTRIES
INDUSTRIAL FOREST DEVELOPMENT

SITE No. 8
GENERAL LOCATION

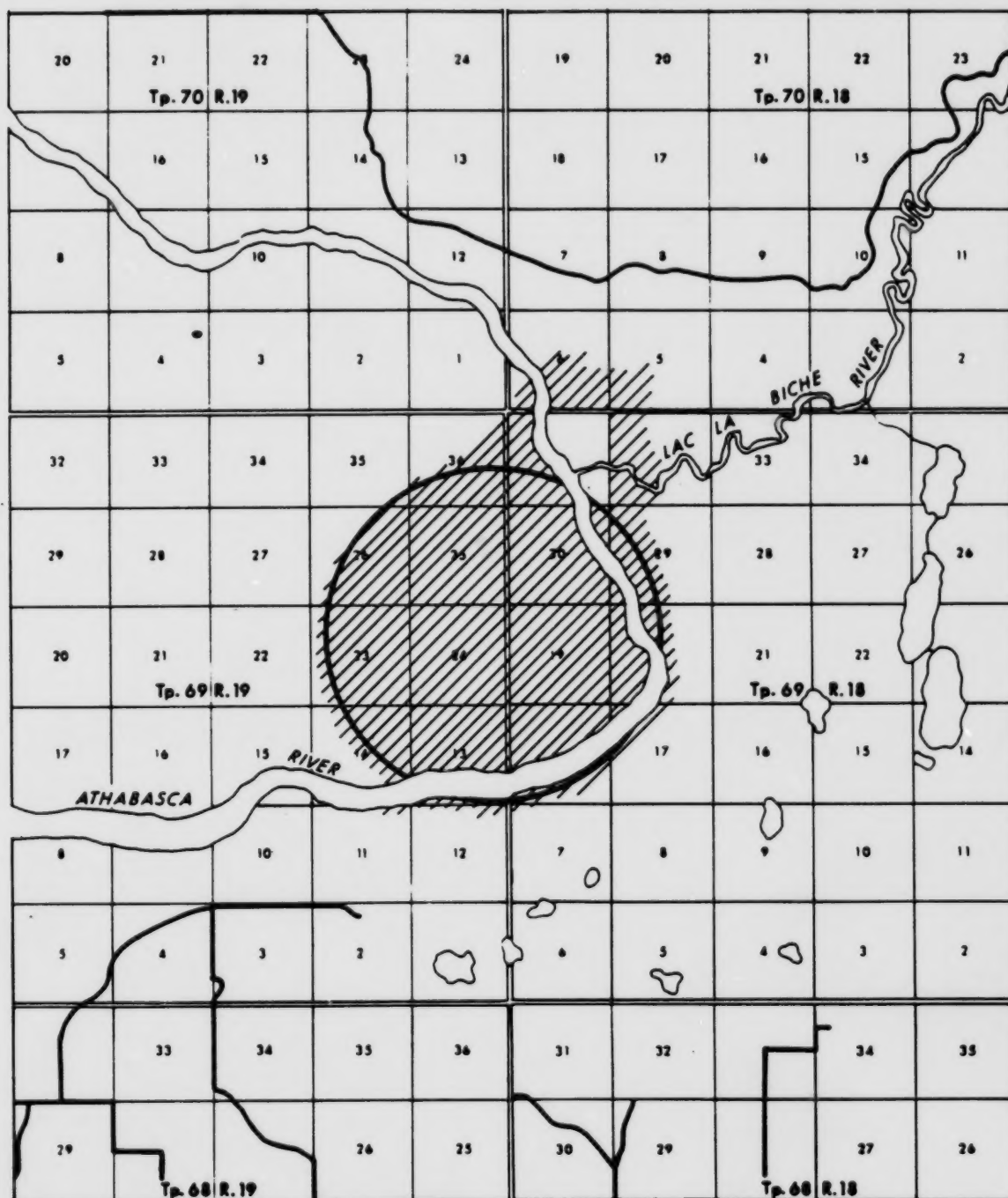


Figure B-9



CRESTBROOK FOREST INDUSTRIES
INDUSTRIAL FOREST DEVELOPMENT

SITE No. 9
GENERAL LOCATION

APPENDIX 6 - NATIVE AFFAIRS SOCIO-ECONOMIC POLICIES AND PROGRAMS

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1.0 INTRODUCTION

The Alberta-Pacific Forest Industries Inc. bleached kraft pulp mill will provide a focus for a wide range of Native interests concerning training, employment and business opportunities, and for concerns about potential changes in community lifestyles, services and infrastructure. The pulp mill will touch on many facets of the regional socio-economic environment, providing both benefits and costs for Native people in the area. The nature and extent of the pulp mill related impacts depend on a host of social, economic, administrative and political factors, including policies and programs intended to manage the effects. For Native people to achieve the greatest possible net benefits from the pulp mill, Alberta-Pacific, its contractors, the government of Alberta and Native community leaders must all contribute to the development of an impact management strategy or policy for the Project. A sincere, co-operative effort by all of these parties in the planning, organization and implementation of such a policy is both desirable and necessary.

Alberta-Pacific Forest Industries Inc. recognizes that as the proponent of the Project, it has a central and distinctive role in the impact management process. This paper describes the Native Affairs Socio-Economic policies and programs that Alberta-Pacific proposes to follow in managing the Project effects.

The policies and proposed programs are presented in three groupings:

- Information, Consultation and Monitoring
- Native Benefits, and
- Mitigation and Compensation.

Alberta-Pacific understands and desires that modification in these programs and policies will arise out of consultation with the Alberta government and local Native community leaders in the region.

2.0 POLICY AND PROGRAM DEVELOPMENT

2.1 POLICY BACKGROUND

Alberta-Pacific proposes to implement a series of policies and programs in order to enhance the beneficial effects and reduce the adverse socio-economic effects of the pulp mill for Native people of the region. In developing these policies and programs, Alberta-Pacific has considered the following impact management perspectives:

- a) To react constructively to the Project, Native people require timely and relevant information about the pulp mill.
- b) Since the number and type of economic opportunities in the region are limited, Native people and businesses may want to participate in Project opportunities to the maximum extent practicable. It is probable that long-term opportunities associated with the Project's operations in woodlands and the pulp mill will be especially attractive to many Native people in comparison with the shorter-term opportunities associated with Project construction.
- c) Alberta-Pacific's abilities to encourage Native employment during construction are heavily influenced by other parties, in particular, government and contractors. Experience with other construction projects suggests that the use of northern contractors to the most practicable extent possible is one of the best ways of ensuring Native employment during the construction phase.
- d) During construction, Project employees and transient immigrants seeking project-related jobs are potential sources of social problems in some Native communities. Project-related personnel and activities could put a strain on transportation, communication, housing and medical services in parts of the north, particularly during construction.

- e) Trapping represents an important source of income (cash and income-in-kind) for some Native residents. Project operations of woodlands and pulp mill activities could disrupt trapping harvest activities at some locations, causing loss of income. To the extent that some of these disruptions are unavoidable, measures for compensation and mitigation need to be established.

Alberta-Pacific has formulated its Native Affairs Socio-Economic Policy on the basis of these perspectives and the foreseeable socio-economic conditions and government policies for resource development projects.

2.2 PROGRAM BACKGROUND

Alberta-Pacific proposes to develop a number of programs in each of the major policy areas. These proposed programs will describe how Alberta-Pacific will implement its Native Affairs Socio-Economic Policies. The information is presented in broad terms; additional information, particularly on the mechanics of implementation, will be developed for Native Affairs Socio-Economic Action Plans to be submitted to Alberta-Pacific after initial permits and licenses are approved.

In developing approaches for implementing the programs, Alberta-Pacific reviewed and assessed leading information, consultation and northern participation programs for major resource development projects in Canada (1). In addition, Alberta-Pacific has relied on previous expertise gained by their personnel in other projects.

The program elements are presented in some detail to demonstrate the approach that Alberta-Pacific feels will be most effective in meeting policy goals. Alberta-Pacific anticipates considerable discussion on the final form of many program elements, as they are transformed into a Socio-Economic Action Plan. Native community consultations will provide an important forum for such discussions.

3.0 INFORMATION, CONSULTATION AND MONITORING

3.1 POLICY

Alberta-Pacific will endeavour to make relevant Project information available and accessible to all interested Native parties on a timely basis. In particular, Alberta-Pacific is prepared to assist Native residents of the region to develop a good understanding of schedules, activities and requirements of operations in woodlands and the pulp mill. Alberta-Pacific will also ensure that participants in the Project, including contractors, management and staff, are briefed on the special interests and concerns of Native people living in the region.

Alberta-Pacific will consult and work closely with all levels of government, in particular Municipal Affairs Native Services Unit, and other appropriate parties during planning, construction and operation of the woodlands and pulp mill phases of the Project, to ensure that potential benefits of the Project are fully realized and that potentially adverse effects are minimized for Native people of the region.

Alberta-Pacific will monitor the application of Native Affairs Socio-Economic Policies, programs and related aspects of Project activities in order to assess their effectiveness and, where necessary, to modify their delivery.

These policies will be implemented through the following programs:

- Information and Liaison
- Consultation
- Project Organization, and
- Monitoring of Socio-Economic Effects.

3.2 PROGRAMS

3.2.1 Information and Liaison

Native Communities

Alberta-Pacific will provide timely Project information to the Native Communities within the region. A series of Project information mailings will serve to introduce key Native community leaders as well as the Native news media to Project developments as they occur. The list will be used to distribute news releases or other announcements and general Project information. Technical information will be simplified, whenever possible, to provide straightforward and clear descriptions of the Project. Alberta-Pacific staff will provide status briefings as required.

Alberta Government

Alberta-Pacific will keep appropriate Municipal Affairs Native Services Unit officials informed of the planning, construction and operation of the woodlands and pulp mill.

Training and Employment Opportunities

- Alberta-Pacific will ensure that the construction and operation of woodlands and pulp mill manpower delivery system contains adequate provision for timely presentation of information about training and employment at the Native community level.
- Alberta-Pacific will undertake an information campaign prior to and during the construction period to advise potential Native job seekers on the appropriate procedures for applying for training and employment.

- Alberta-Pacific contractors will be required to make information about employment requirements available for Native community dissemination as soon as possible after they have been awarded a contract and to update this information on a regular basis.
- Alberta-Pacific will establish a toll-free telephone service that will enable Native community residents to make enquiries about training and employment opportunities.
- Alberta-Pacific will ensure that the project manpower delivery system contains adequate provision for rapid advertising of job vacancies.

Business Opportunities

- Alberta-Pacific will prepare a listing of Project requirements that could be of special interest to Native businesses. This list will be prepared well in advance of the requirements and will be updated periodically.
- Alberta-Pacific staff will make periodic visits to Native communities to meet with Native businessmen in order to assess their business capabilities and discuss project requirements.
- Alberta-Pacific will prepare and continually update a list of Native businesses that are interested in, and potentially capable of participating in, Project supply opportunities. This list will be distributed to all personnel involved in Project contracting or purchasing.
- Alberta-Pacific will produce a periodic summary of business opportunities arising from the Project. This will be distributed to Native businesses that have an expressed interest in business opportunities.

- Alberta-Pacific will locate a Project office at the Project site as soon as possible which will enable Native businesses wide accessibility for business opportunities.
- Alberta-Pacific will provide toll-free long distance telephone service for Native businessmen wishing to contact the company.

3.2.2 Consultation

Native Community

- Alberta-Pacific feels that a regional Native advisory group(s) would assist the company in ensuring that regional and local concerns are taken into account during planning. The terms of reference, composition and reporting procedures of such an advisory group, or the means by which existing regional groups might be used, will be discussed with appropriate Native community leaders. For example, regional economic development corporations may be able to perform such an advisory function where they exist. Where appropriate, Alberta-Pacific will invite Native groups (for example, a Band Council, a Metis Settlement Council, a Metis Local, etc.) to become familiar with pulp mill construction or operations through facility tours or demonstrations.
- Alberta-Pacific will consult with appropriate regional Native groups regarding such topics as training programs, environmental issues, subsistence living (hunting, trapping and fishing), forest management, local financial services, etc.

Training and Employment Programs

- Consultation at the Native community level is essential to the development of Alberta-Pacific's training and employment programs. Following initial Native community meetings and open houses,

Alberta-Pacific staff will be available for followup meetings to provide details on specific aspects of the Project.

- Alberta-Pacific will work with Native communities and others to develop and implement a project manpower delivery system that enables Native residents to participate in employment opportunities.
- Alberta-Pacific will work with Native communities and others to develop training programs for potential employees in all phases of the project and will publicize the requirements well in advance of construction.

Business Opportunities

- The operations of woodlands and pulp mill of the Project will provide opportunities for the establishment or support of a number of Native businesses.
- Alberta-Pacific staff will fill a key role in consultations with Native communities regarding Native businesses.

3.2.3 Project Organization

Regional Coordinator and Native Communities Information and Liaison Officers

Alberta-Pacific will employ or contract northern Albertan residents as a Regional Coordinator and local Native communities information and liaison officers to provide a liaison and consultation function with the Alberta government, Municipal Affairs Native Services Unit and Native communities involved with the Project. The officers will perform key roles in information and liaison activities to ensure that information on the Project is reaching key government and Native people

effectively. The Regional Coordinator will perform a similar key function in the ongoing development and maintenance of community consultation.

Alberta-Pacific Staff Orientation

Alberta-Pacific will ensure that all staff and contractors are knowledgeable of the special interests and concerns of Native people living within the region. Where appropriate, cross-cultural workshops and seminars will be used as an orientation technique.

3.2.4 Monitoring of Socio-Economic Effects

Alberta-Pacific will establish a monitoring system that will keep management informed of:

- the effectiveness of Alberta-Pacific's Native Affairs Socio-Economic policies and programs during the construction and initial operations of woodlands and pulp mill phases
- the implications of unanticipated developments
- suggestions for corrective action made by others, and
- unsettled land claims in the region.

Alberta-Pacific will work with Native communities to develop systems for monitoring and controlling company activities near the Native communities and in the vicinity of important resource harvesting or cultural areas.

4.0 NATIVE BENEFITS

4.1 POLICY

Alberta-Pacific is committed to enabling Native residents and Native businesses in the region to participate in training, employment and business opportunities generated during construction and operation of woodlands and the pulp mill. Alberta-Pacific will encourage Native participation wherever it is practicable, taking into account Project requirements, scheduling and cost considerations, and the capabilities of Native residents and Native businesses. Wherever the capability exists or could reasonably be developed for a Native resident or Native business to compete for a Project opportunity, special efforts will be made to assist them in participating.

The policies will be established through the following programs:

- Native business
- Native training, and
- Native employment.

4.2 PROGRAMS

4.2.1 Native Business

Five of the information and liaison activities outlined earlier are intended to increase the opportunities for Native businesses to benefit from the Alberta-Pacific Bleached Kraft Pulp mill. These activities are:

- preparation of a Project industrial and service list
- familiarization visits
- preparation of a list of Native businesses
- periodic summaries of Native opportunities, and
- establishment of toll-free long distance telephone service.

Helping Native Business to Prepare Bids

Formation of New Native Businesses

Alberta-Pacific will encourage the formation of new businesses and Native economic development corporations that would be able to meet Project supply requirements. Assistance could include the provision of detailed information about relevant requirements, advice in finding consultants for feasibility and other studies, and the provision of information to third parties outlining potential use by the Project of services from a new business, e.g. financial institutions.

Since Alberta-Pacific hopes that its activities will contribute to stable, long-term growth in the Native business sector, it is prepared to direct special attention to new Native businesses with long-term viability.

Joint Ventures

Alberta-Pacific will encourage the formation of joint venture groups that will facilitate the participation of Native businesses in Project requirements. Alberta-Pacific anticipates that such joint venture endeavors will yield long-term benefits through contributing to the transfer of technology and management expertise to Natives.

Fragmentation of Work Packages

Where practicable and appropriate, Alberta-Pacific will ensure that certain Project requirements will be broken down into packages that the regional Native businesses can supply.

Measures to Assist Native Contractors

Native Contracts

Alberta-Pacific will make all Native contracts of woodlands and pulp mill work in written form.

Prompt Payments

Native businesses will be paid within 30 days of the receipt of a proper invoice.

Progress Payments

Alberta-Pacific will consider making progress payments to Native businesses experiencing significant cash flow difficulties.

Advice and Assistance

Where appropriate, Alberta-Pacific will provide on-going technical, supervisory and administrative assistance to a Native business that has been awarded a contract related to the Project. The form of assistance will be determined by the situation.

Assistance in Arranging Financing

Where appropriate, Alberta-Pacific will assist in arranging financing to carry out the work on a contract or purchase related to the Project. Assistance could include attending meetings with financial institutions or making provision for direct payments of a portion of invoiced amounts to a financial institution.

Responsibility and Reporting

Responsibility for Implementation

Alberta-Pacific management will ensure implementation of the Native business, training and employment programs during planning, construction and operation of woodlands and pulp mill.

Status Report

Reports on the progress and performance of the Native business, training and employment programs will be submitted to senior management.

4.2.2 Native Training

Planning Training Programs

Alberta-Pacific will ensure that the construction manpower delivery system contains adequate provision for the planning of training programs for potential construction Native employees.

Alberta-Pacific will work closely with educational institutions and the Alberta government to ensure that the basic educational, skill and training requirements of the administration of the operations of woodlands and pulp mill phase jobs are identified at an early stage. This would allow those Native residents interested in taking advantage of training and employment opportunities offered by the Project a period of time to pursue academic or vocational upgrading, if necessary.

Alberta-Pacific will work with the Alberta government to develop and implement a Native training plan. This plan will outline the role of the Alberta government as well as that of the company in providing

training opportunities that can lead to permanent employment and ongoing career development.

Pre-Employment, On-Site and On-the-Job Training

Construction Phase

Alberta-Pacific will ensure that the construction manpower delivery system contains adequate provision for the entry of Native residents into pre-employment and pre-season training programs.

Alberta-Pacific will contribute, through provision of information, advice and priority hiring of graduates, to the development of government-sponsored pre-employment training programs for Native residents that are geared to labour requirement schedules.

Operations of Woodlands and Pulp Mill Phase

Alberta-Pacific will establish a training program to enable Native residents to qualify for positions within the woodlands and pulp mill operations. The program may operate on a "letter of intent" basis, whereby Native residents will be offered employment with Alberta-Pacific subject to completion of basic education requirements and a period of on-the-job training.

The training program for certain technical positions may include a period of employment at an existing bleached kraft pulp mill outside the Alberta-Pacific forest management agreement area. Wherever possible, Native residents in training outside the region will alternate between their home community and their training location. Once the Alberta-Pacific project commences operation, the training program will be moved to the site headquarters.

Alberta-Pacific will explore the possibility of establishing an in-house technical training program in cooperation with Alberta Vocational Centres in the region, the Alberta government and the Canada Employment and Immigration Commission. The in-house program may include short courses and in-service material on particular subjects, as well as longer programs. Alberta-Pacific will take into consideration principles of cross-cultural education and communication in the design of its training programs.

Orientation and Counselling

Orientation

Alberta-Pacific will ensure that all Native staff receive an appropriate orientation briefing at the beginning of their employment. The briefing will include:

- an explanation of Alberta-Pacific policies and applicable government regulations, including those pertaining to environmental and socio-economic matters
- an explanation of the type of counselling services provided by Alberta-Pacific, and
- safety regulations, practices and procedures.

Counselling

Alberta-Pacific will provide counselling services for Native employees during operations of woodlands and pulp mill. These services will include advice on financial matters, career planning, training programs, and adjustment to relocation (or rotation) and the work schedule. Alberta-Pacific will endeavour to ensure that employees are knowledgeable of available government counselling programs.

During the operations of woodlands and pulp mill phase, the Project will be staffed with a personnel or counselling employee who is able to discuss concerns with Native employees in their own language if they so desire.

4.2.3 Native Employment

Alberta-Pacific has limited control over many of the key activities that determine the degree of Native employment occurring during Project construction. Other groups, in particular contractors and government manpower agencies, also have significant influence. In light of this, Alberta-Pacific believes that an ongoing working relationship between government, contractors and Native communities and itself is necessary in order for a meaningful and effective approach to Native employment to materialize during the construction of the pulp mill. The initiatives of Alberta-Pacific itself are only one part of an overall construction manpower delivery system for Native residents.

A number of activities outlined above under the information and liaison program are intended to increase the opportunities for employment of Native residents on the Alberta-Pacific project. Those activities include:

- timely presentation of information
- establishment of a toll-free telephone service, and
- rapid advertising of job vacancies.

Objectives and Consultation

As mentioned above, Alberta-Pacific will consult closely with government, Native communities and contractors to develop and implement a construction manpower delivery system to enable Native residents to participate in the woodlands and pulp mill operations.

Alberta-Pacific will encourage employment in the operation of woodlands and the pulp mill for Native residents and will implement a number of activities to ensure that Native residents have advance information about, and the opportunity to receive, Project employment.

Use of Native Contractors as a Means of Native Employment

As noted above, Alberta-Pacific intends to adopt a Native business policy that will ensure substantial participation by Native businesses in the Project. This strategy, which includes provision for a series of Native contracts, is also intended to encourage Native employment opportunities for Native residents in those activities best suited to their experience and qualifications.

Recruiting and Hiring

Recruiting

Alberta-Pacific will ensure that the Project manpower delivery system contains adequate provision for a proactive, Project oriented system for recruiting Native residents. Upon request of Alberta-Pacific, contractors will be required to participate in recruiting trips to Native communities.

Alberta-Pacific will provide an opportunity for Native residents, employed during construction of the Project, to apply for operations of woodlands and pulp mill jobs.

For operations of woodlands and pulp mill jobs, Alberta-Pacific field staff will also visit communities in the region on recruiting tours to take applications for employment from Native residents. Field staff will conduct initial interviews and suitable qualified candidates will be placed on a waiting list for further candidate selection.

For operations of woodlands and pulp mill phase jobs, Alberta-Pacific will also work with Canada Manpower Centres and Alberta Native Outreach to facilitate candidate recruitment.

Special Employment Measures

Alberta-Pacific will be sensitive to the need to ensure that Native residents, women and the handicapped receive full opportunity to participate in Project training and employment opportunities.

5.0 MITIGATION AND COMPENSATION

5.1 POLICY

Wherever possible, Alberta-Pacific intends to reduce or eliminate any adverse Native socio-economic effects of the operation of woodlands and the pulp mill. Mitigative measures are proposed for application to the location of Project facilities and scheduling of activities, for the control of Project personnel and for the reduction of any effects of Project development on Native community services and infrastructure. Alberta-Pacific will participate in programs to compensate for its effects on Native resource harvesting activities according to the applicable government policies and regulations.

These policies will be established through the following programs:

- Location and Scheduling of Activities and Facilities
- Control of Project Personnel
- Native Community Services and Infrastructure, and
- Native Trapper's Compensation.

5.2 PROGRAMS

5.2.1 Location and Scheduling of Activities and Facilities

Location of Facilities

Alberta-Pacific will endeavour to locate facilities away from Native communities, camps and key resource harvesting areas in order to avoid interfering with local Native activities.

Scheduling of Construction Activities

Alberta-Pacific will endeavour to schedule construction activities in order to minimize any potential for conflicts with Native resource harvesting or disturbance of cultural areas.

5.2.2 Control of Project Personnel

Controlling Contact with Native Communities

Alberta-Pacific is prepared to discipline, within the law, all personnel to prevent disturbance of Native communities, camps and resource harvesting areas.

Firearms

During construction, Project personnel will not be permitted to have privately owned firearms at Alberta-Pacific facilities. Alberta-Pacific firearms issued for safety purposes will be strictly controlled and written reports will be required whenever a firearm is discharged.

Hunting, Trapping and Fishing

During construction, Project personnel will not be allowed to hunt or trap while residing at Alberta-Pacific facilities. Alberta-Pacific will discuss with the appropriate authorities possible restrictions on fishing at locations adjacent to the facilities that are known to be used for Native fishing.

Use of Company Vehicles

Alberta-Pacific personnel will not be permitted to use Project vehicles, boats or aircraft for any of the following purposes contrary to Alberta government regulations:

- to follow, harass or otherwise disturb wildlife
- to travel to areas of wildlife concentration or to hunting, trapping and fishing locations, and
- to transport animal carcasses, furs or hides.

Government Regulations

Alberta-Pacific will ensure that all Project personnel are made aware of government regulations pertaining to hunting, fishing and trapping in various areas of the region.

Controlling Alcohol and Illicit Drugs

Alberta-Pacific will discuss with the appropriate regulatory authorities the best means of controlling alcohol and illicit drugs in its facilities.

5.2.3 Native Community Services and Infrastructure

Alberta-Pacific will endeavour to ensure that Project-related requirements for transportation communications, resupply networks, housing and government services, particularly during the construction phase, do not interfere with Native communities' requirements.

Essential Native Community Services

Alberta-Pacific will cooperate with appropriate government departments to ensure that essential services in Native communities are not jeopardized if key Native residents pursue pulp mill employment.

5.2.4 Native Trapper's Compensation

In the context of current practice in Alberta, Alberta-Pacific is prepared to work with government and Native communities to ensure that appropriate types and methods of compensation are developed prior to the beginning of construction. In particular, Alberta-Pacific is prepared to provide compensation for a demonstrated reduction in trapping harvest as a result of Project activity.

Native Trapper's Compensation Plan

Alberta-Pacific will prepare a detailed Native Trapper's Compensation Plan that will be submitted as part of the Project's Native Affairs Socio-Economic Action Plan. The compensation plan will reflect the Alberta-Pacific attitude that prevention of impact on renewable resources is a high priority, but that where Project related impacts on trapping harvest cannot be avoided or satisfactorily mitigated, compensation will be made available. The Native Trapper's Compensation Plan will be based on the recognition that those persons dependent on trapping for their livelihood require protection from adverse impacts of resource development on renewable resources and on their ability to harvest these resources.

The Native Trapper's Compensation Plan will be developed by the Project with advice from the Native Communities and individual Native trappers in the context of the policies of the appropriate government departments. This plan will form the basis for a compensation agreement between Alberta-Pacific and the potentially affected Native trappers. This compensation agreement will be submitted to the relevant government departments for approval prior to the commencement of construction.

Alberta-Pacific will designate a Project employee as a Claims Officer who can assist with completion of claim forms and who will be responsible for processing any claim.

6.0 REFERENCES

The compiler of this Native Affairs Socio-Economic Policy has benefitted from reviewing the socio-economic policies of the following companies: Polar Gas Project, Artic Pilot Project, Pan Arctic Oil and Gas Ltd., Dome Petroleum and Petro Canada Resources Ltd.

The combined experiences of the above companies constitutes, in the writer's opinion, the state-of-the-art in Canadian Native Affairs policies and programs for resource development.



APPENDIX 7 HEALTH IMPACTS

Following a review of the literature and personal interviews, I am unable to find any reason to suspect any toxic effects from either the air or water emissions from this mill. This proposed modern Kraft Mill, which is to be built by Alberta-Pacific Forest Industries Inc. (APFI), addresses the concerns outlined in an earlier report (1).

It is evident that the sulfur dioxide emissions from the stack will be below the levels which affect both normal persons and those with asthma (2). The hydrogen sulfide levels, even under worst case scenarios, would not be expected to present any toxicological problems in humans or livestock (3, 4). Dr. B. Beck (3) has pointed out that, "Some animals, as is the case with humans, may show unusual sensitivity, and animals experiencing other diseases may be adversely affected" during an oilwell blowout. He also points out that problems of abortion, infertility and residues in meat do not occur and that trace mineral deficiencies, decreased milk yield and weight gains, and long term debility have not been substantiated by scientific documentation. The emissions of hydrogen sulfide are much higher under the conditions Dr. Beck is addressing than those that would occur from this Kraft Mill.

No data were available on the particulate (2.5 - 0.3 μ m) emissions of sulfuric acid. These particles could result from the interaction of sulfur dioxide and water vapour. Because the sulfur dioxide emissions are so low, little sulfuric acid would be expected.

An examination of the potential inorganic, acidic, phenolic, and basic organic compounds in the wastewater effluent from an existing Kraft Mill (5) indicate little likelihood of toxicological problems from the Alberta-Pacific Forest Products Inc. Kraft Mill. Wastewater will undergo a three step cleanup prior to discharge. Incineration of waste materials will be at temperatures which are sufficiently high that toxic products resulting from combustion are not anticipated.

Since this report is intended to address public concerns about toxicology, I believe a brief reference to dioxin (2,3,7,8-tetrachlorodibenzo-p-dioxin) is in order. The only human health problem definitely associated with dioxin is chloracne and that has come only from relatively high exposures. No convincing evidence links exposure to dioxin with cancer in humans. Nevertheless, it will be desirable to keep dioxin concentrations as low as possible in plant effluents and to have concentrations assayed once the plant is operational.

Oxygen demand, both chemical (COD) and biological (BOD) will continue to be a growing concern in the future. Furthermore, colored effluent simply conjures up other problems and while the substances responsible are not of toxicological concern, the brown color certainly invites questions on behalf of a concerned public.

The opinions expressed in this report are based on the information available to the author at the time of its preparation (6). If the design criteria are not met, or if unknown or unanticipated toxic substances appear in the effluents, then a reevaluation of the health impact of the Alberta-Pacific Forest Industries Inc. Bleached Kraft Mill will be required.

J.D. Taylor, Ph.D.
Toxicologist

89/02/28

References cited in this report:

- (1) Health effects from Kraft (Sulfate) pulp mill operations. Hawkes, M.P.G., Alberta Environmental Conservation Authority 1976.
- (2) Exercise increases sulfur dioxide-induced bronchoconstriction in asthmatic subjects. Sheppard, D., Saisho, A., Nadel, J.A., and Boushey, H.A. Am. Rev Respir Dis 1981; 123: 486-491.
- (3) Highly toxic chemicals: Detection and protection methods. Proceedings of an international symposium. Ed. Schiefer, H.B. 1985.
- (4) Hydrogen sulfide in the atmospheric environment: National Research Council Canada No. 18467, 1981.
- (5) Alberta Environmental Centre. Toxicity and environmental chemistry of wastewater from a Kraft Pulp and Paper Mill: Fish toxicity studies. Alberta Environmental Centre. Vegreville, Ab. 67p, 1987 AECV87-R4.
- (6) Personal communications: Dr. Arnold Lamb, Senior Consultant Environment, Stanley Associates Engineering Ltd. and Mr. Malcolm Palmiere, Alberta-Pacific Forest Industries Inc.



TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR		UNCONFINED COMPRESSION kPa			
WEIGHT HAMMER 63.5 Kg					ELEV GROUND 576.3 m		100 200 300 400			
HEIGHT DROP 0.76 m					CO-ORD. LOCATION See Drawing B-2499-1		● FIELD VANE ▲ LAB VANE ■ UNCONF.			
DEPTH ELEV	O.D. T.B.	BLOW 1.5m	NO.		DESCRIPTION OF MATERIAL		PLASTIC LIMIT	WATER CONTENT	LIQUID LIMIT	
						X 10	30	0 60	70	80 %
	B		1	0.3 m	TOPSOIL					
1.0	B	3	2		SAND					
	SPT	4	3		- some silt					
		4			- trace clay					
				1.7 m	- poorly graded, fine grained					
					- loose					
2.0	B		4		SAND AND SILT					
					- some gravel sizes					
	SPT	20	5	2.7 m	- clayey, very dense					
3.0		25			- low to medium plasticity					
		50			- rust marks, brown					
	B		6		CLAY (TILL)					> ■
4.0					- little silt					
					- trace of sand					
					- medium to high plasticity					
5.0					- trace of gravel and pebbles					
					- few silt pockets					
					- very stiff to hard					
					- dark grey					
6.0	SY	REC 0.23	7							■
	SPT	11	8							■
		17								
		25								
7.0										
	SPT	11	9							■
		13								
		21								
8.0										
	SPT	7	10							
		14								
9.0		19								
	SY	REC 0.29m	3A							
	SPT	10	4A							
10.0		26								
		29								
					-no recovery					



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JOB No. PA 2499.02
PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. TH 88-1
DATE JULY 27, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR		UNCONFINED COMPRESSION kPa			
DEPTH ELEV	O.D. T.D.	BLOW COUNT	NO.		ELEV GROUND	CO-ORD. LOCATION	FIELD VANE	LAB VANE	UNCONF	
WEIGHT HAMMER 63.5 Kg					576.3 m		100 200 300 400			
HEIGHT DROP 0.76 m							PLASTIC LIMIT WATER CONTENT LIQUID LIMIT			
					DESCRIPTION OF MATERIAL		X 10 20 30 40 50 60 70 80 90 X			
11.0	SPT	11 16 29	11		CLAY (LACUSTRINE) - medium to high plasticity - very stiff - slight laminations - occasional pebble - dark brown					
12.0	SPT	11 19 34	12		Grain Size Analysis (Aug 30/88) Sa 11: 2% Fine Gravel 16% Sand 42% Silt 40% Clay					
13.0	B		13		CLAY (TILL)					
14.0	SPT	18 25 32	14							
15.0					- harder material at 14.6 m, advancing difficult with wet rotary drill					
16.0	SPT	10 23 86	15							
17.0	SPT	15 35 45	16	9A	SPT 17 36 50/0.1 m					
18.0					CLAY (TILL)					
19.0										
20.0	SPT		10A							



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PROJECT ALBERTA PROJECT

LOCATION ATHABASCA AREA

HOLE No. TH 88-1

DATE JULY 27, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR		UNCONFINED COMPRESSION kPa			
WEIGHT HAMMER 43.3 kg					ELEV GROUND 576.3 m		100 200 300 400			
HEIGHT DROP 0.76 m					CO-ORD. LOCATION		FIELD VANE LAB VANE UNCONF			
DEPTH ELEV	O.D. T.O.	BLOWS 15m	NO.		DESCRIPTION OF MATERIAL		PLASTIC LIMIT	WATER CONTENT	LIQUID LIMIT	
21.0	SPT	22 40 60	10A	CLAY (TILL) - silty - trace sand, trace gravel - medium plasticity - dark grey, hard					>■	
22.0				21.3 m CLAYSTONE (BEDROCK) - trace fine sand - trace silt - high plasticity - dark grey - hard						
23.0	B		11A	Grain Size Analysis (Aug 30/88) Sa 12A: 11% Fine Sand 45% Silt 44% Clay						
24.0										
25.0	SPT	16 20 30	12A	NOTES: 1. Solid stem auger to 13.5 m; hollow stem to 16.5 m. 2. Refusal to augering at 16.5 m. 3. Water at 10.4 m after auger drilling. 4. Wet rotary drill to 27.9 m, Aug 17, 1988. 5. End of hole in bedrock at 27.9 m.		X---X			>■	
26.0										
27.0										
28.0	SPT	40 55 50/ 0.1m	13A	27.9 m					>■	
29.0				END OF HOLE						
30.0										



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HOLE No. TH 88-1
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1

1



JOB No.	PA 2499.02
PROJECT	ALBERTA PROJECT
LOCATION	ATHABASCA AREA
HOLE No.	TH 88-2
DATE	JULY 28, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR	UNCONFINED COMPRESSION kPa											
WEIGHT HAMMER 63.5 Kg					ELEV GROUND	100 200 300 400											
HEIGHT DROP 0.76 m					CO-ORD. LOCATION	FIELD VANE LAB VANE UNCONF											
DEPTH ELEV	O.D. T.O.	BLOW COUNT	NO.		DESCRIPTION OF MATERIAL				PLASTIC LIMIT	WATER CONTENT	LIQUID LIMIT						
								X	10	30	0	80	70	90	X		
11.0	SPT	18 22 32	11	CLAY (TILL) - trace to little sand - trace silt - medium to high plasticity - little gravel - dark grey - hard													
12.0	SPT	14 24 48	12														
13.0	SPT	14 28 42	13		13.4 m												
14.0				END OF HOLE NOTES: 1. End of hole at 13.4 m. 2. Solid stem auger drill used to 6.9 m. 3. Sloughing to 3.0 m. 4. Hollow stem auger drill used from 6.9 m to refusal at 13.4 m.													
15.0																	



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JOB No. PA 2499.02
PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. TH 88-2
DATE JULY 28, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR		UNCONFINED COMPRESSION kPa			
WEIGHT HAMMER 63.5 Kg					ELEV GROUND		100 200 300 400			
WEIGHT DROP 0.76 m					CO-ORD. LOCATION See Drawing B-2499-1		FIELD VANE LAB VANE UNCONF.			
DEPTH ELEV	O.D. T.D.	BLOW 15m	NO.		DESCRIPTION OF MATERIAL		PLASTIC LIMIT	WATER CONTENT	LIQUID LIMIT	
						X	0	X		
						10	80	80	70	90
					0.3m	TOPSOIL				
1.0	B		1			SAND, mostly fine - little to some silt - trace clay (layers/ pockets) - dark rusty-brown - loose				
2.0	B		2							
3.0	SPT	6 5 9	3			layer of brown silty gravel trace of organics				
4.0	SPT	20 43 52	4			- very dense below 4.0 m - contains thin clayey silt layers up to 50 mm thick - saturated below 4.0 m				
5.0										
6.0	SPT	15 14 18	5							
7.0	SPT	6 7 9	6		6.0 m	CLAY (TILL) - silty - little sand - medium plasticity - little gravel - dark grey - stiff - layers of saturated light grey medium to fine sand				
8.0										
9.0	SPT	12 12	7							
10.0										



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JOB No. PA 2499.02
PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. TH 88-3
DATE JULY 28, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR	UNCONFINED COMPRESSION kPa			
WEIGHT HAMMER 63.5 kg					ELEV GROUND	100 200 300 400			
HEIGHT DROP 0.76 m					CO-ORD. LOCATION	● FIELD VANE ▲ LAB VANE ■ UNCONF.			
DEPTH ELEV	O.D. T.O.	BLOW COUNT	NO.		DESCRIPTION OF MATERIAL	PLASTIC LIMIT X	WATER CONTENT 0	LIQUID LIMIT X	
11.0	SPT	8 11 18	8	CLAY - little silt, trace of sand - high plasticity - very stiff, dark grey					
12.0	SPT	9 13 15	9		hard till layer				
13.0									
14.0	STP	7 12 17	10	- pockets of silt - slightly laminated					
15.0	SPT	7 14 20	11	15.0 m					
16.0	END OF HOLE								
17.0	NOTES: 1. End of hole at 15.0 m.								
18.0	2. Solid stem auger drill used to 2.8 m								
19.0	3. Sloughing to 2.5 m.								
20.0	4. Hollow stem auger drill used to refusal at 15.0 m.								



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JOB No. PA 2499.02
PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. TH 88-3
DATE JULY 28, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR		UNCONFINED COMPRESSION kPa					
WEIGHT HAMMER 63.5 Kg					ELEV GROUND 570.7 m		100 200 300 400					
HEIGHT DROP 0.76 m					CO-ORD. LOCATION See Drawing B-2499-1		FIELD VANE LAB VANE UNCONF.					
DEPTH ELEV	O.D. I.D.	BLOW COUNT	NO.	DESCRIPTION OF MATERIAL		PLASTIC LIMIT		WATER CONTENT		LIQUID LIMIT		
						X 10 20 30 40 50 60 70 80 90 100						
1.0	B		1	SAND, very fine, uniform - little silt - trace clay - organics/rootlets to 1.3 m - dark brown to oxidized brown turning grey at 1.9 m - wet at 2.0 m								
	B		2									
2.0	B		3									
3.0	SPT	11 6 6	4									
	B		5									
4.0	SY	REC	6	3.8m								
	SPT	23 23 52	7	SAND AND SILT - some gravel sizes - layered silt, sand and clay - medium plasticity - very dense - saturated - brown to dark brown								
5.0												
	SPT	75/ 0.15	8									
6.0												
7.0	SPT	45 60	9									
8.0				Grain Size Analysis (Aug 30/88) Sa 9: 3% Medium Sand 79% Fine Sand 18% Silt/Clay								
	SPT	11 18 23	10									
9.0												
10.0	SPT		11									



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JOB No. PA 2499.02
PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. TH 88-5
DATE JULY 27/88 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR		UNCONFINED COMPRESSION kPa			
WEIGHT HAMMER 63.5 kg					ELEV GROUND 570.7 m		100 200 300 400			
HEIGHT DROP 0.76 m					CO-ORD. LOCATION		FIELD VANE LAB VANE UNCONF			
DEPTH ELEV	O.D. I.D.	BLOWS 15m	NO.		DESCRIPTION OF MATERIAL		PLASTIC LIMIT	WATER CONTENT	LIQUID LIMIT	
11.0		19 22 75	11	CLAY - trace silt - trace sand - medium to high plasticity - dark grey - stiff	Grain Size Analysis: (Aug 30/88) 11% F. Sand 42% Silt 47% Clay					
	B		12							
12.0		16 25 40	3A			No recovery *second attempt				
13.0		10 18 30	3A*							
14.0	B		4A	CLAYSTONE (BEDROCK) - trace silt - trace very fine sand - high plasticity - slickensides - sand partings - dark grey - hard						
15.0		24 35 40	5A							
16.0										
17.0										
18.0		22 32 45	6A							
19.0										
20.0										



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PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. TH 88-5
DATE JULY 27, 1988 PLATE

TEST HOLE LOG

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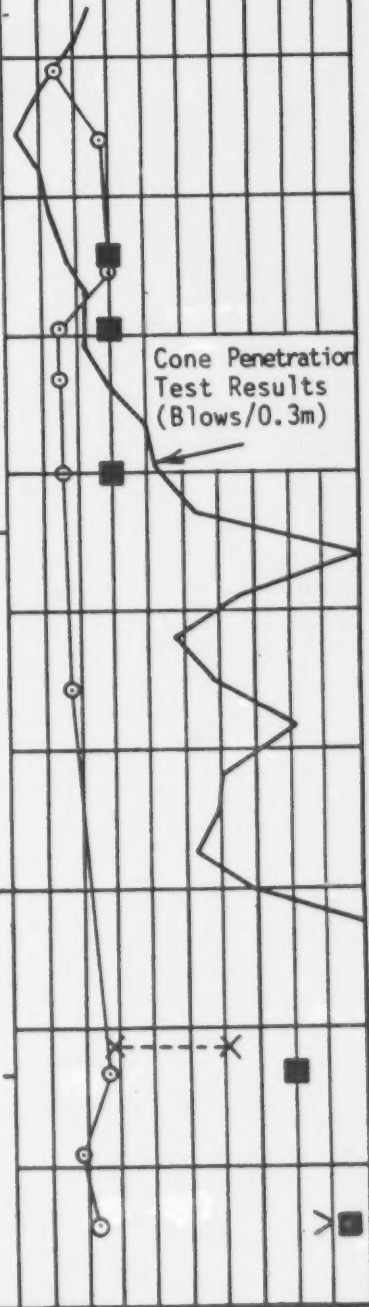
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PROJECT	ALBERTA PROJECT
LOCATION	ATHABASCA AREA
HOLE No.	TH 88-5
DATE	JULY 27, 1988 PLATE



TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR		UNCONFINED COMPRESSION kPa			
WEIGHT HAMMER 63.5 Kg					ELEV GROUND 566.2 m		100 200 300 400			
HEIGHT DROP 0.76 m					CO-ORD. LOCATION See Drawing B-2499-1		● FIELD VANE ▲ LAB VANE ■ UNCONF.			
DEPTH ELEV	O.D. I.D.	BLOWS 15m	NO.		DESCRIPTION OF MATERIAL		PLASTIC LIMIT X	WATER CONTENT O	LIQUID LIMIT X	
1.0		11			SAND - poorly graded, medium to fine grained - some silt - trace clay - layered/laminated - brown					
		7	1							
		6			1.4 m					
2.0			2		SILT AND SAND - clayed - some gravel sizes to 50 mm - medium plasticity - laminated - firm to stiff - mottled brown					
		REC 0.34m	3							
3.0		7	4							
		12	5							
		20								
4.0		10			SAND, mostly fine - little stiff, clean - saturated - medium dense - brown					
		10	6							
		14								
5.0										
		4								
		8	7							
6.0		13								
		11								
		14	1A							
		17								
7.0					7.0 m					
			2A		CLAY (LACUSTRINE) - trace silt - trace very fine sand - high plasticity - sand partings - slickensides - dark grey - very stiff to hard					
		13								
8.0		21	3A							
		36								
		REC 0.3m	8							
9.0		12								
		19	9							
		25								
10.0										



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JOB No. PA 2499.02
PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. TH 88-6
DATE JULY 27, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR		UNCONFINED COMPRESSION kPa				
WEIGHT HAMMER 63.5 kg					ELEV GROUND 566.2 m		100 200 300 400				
HEIGHT DROP 0.76 m					CO-ORD LOCATION		FIELD VANE LAB VANE UNCONF				
DEPTH ELEV	O.D T.B	BLOW 1.5m	NO.		DESCRIPTION OF MATERIAL		PLASTIC LIMIT		WATER CONTENT		LIQUID LIMIT
						X 10 20 30 40 50 60 70 80 90 X					
11.0					CLAY (LACUSTRINE) - trace silt, trace very fine sand - high plasticity - sand partings, slickensides - dark grey - very stiff to hard						
12.0	SPT	100/0.1m	5A		11.9 m						
13.0	B		6A		CLAYSTONE (BEDROCK) - trace silt - trace very fine sand, partings - high plasticity - dark grey - hard						
14.0	B		7A								
15.0	SPT	30/60	8A		15.5 m						
16.0					END OF HOLE						
NOTES:					1. Solid stem augered to 9.2 m. 2. Auger refusal at 9.2 m. 3. Water at 2.8 m after augering. 4. Wet rotary drill to 15.5 m August 16, 1988. 5. End of hole in bedrock at 15.5 m.						

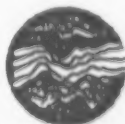


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JOB No. PA 2499.02.01
PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. TH88-6
DATE JULY 27, 1988 PLATE

TEST HOLE LOG

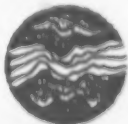
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WEIGHT HAMMER 63.3 Kg					ELEV GROUND	100 200 300 400			
HEIGHT DROP 0.76 m					CO-ORD. LOCATION See Drawing D-2499-2	● FIELD VANE ▲ LAB VANE ■ UNCONF			
DEPTH ELEV	O.D. 1.0	BLOW 15m	NO.		DESCRIPTION OF MATERIAL	PLASTIC LIMIT X	WATER CONTENT 0	LIQUID LIMIT X	
1.0	B		1	SAND - very fine - uniform - trace fines - brown					
2.0									
	B		2	2.4 m					
3.0	SPT	4 3 2	3	SAND AND GRAVEL - poorly graded - little fines - slight plasticity - rust brown - saturated					
4.0				3.5 m					
	SPT	9 11 19	4	CLAY (TILL) - little silt - little sand - medium plasticity - trace gravel - dark grey - hard			> ■		
5.0									
6.0	SPT	8 10 16	5				> ■		
7.0									
	SY	REC. 0.22m	6				■		
8.0	SPT	10 17 25	7				■		
	SPT	12 16 24	8	8.5 m CLAYSTONE (BEDROCK) - trace silt - trace fine sand, partings - high plasticity - slickensides - dark grey, hard			> ■		
9.0									
10.0									



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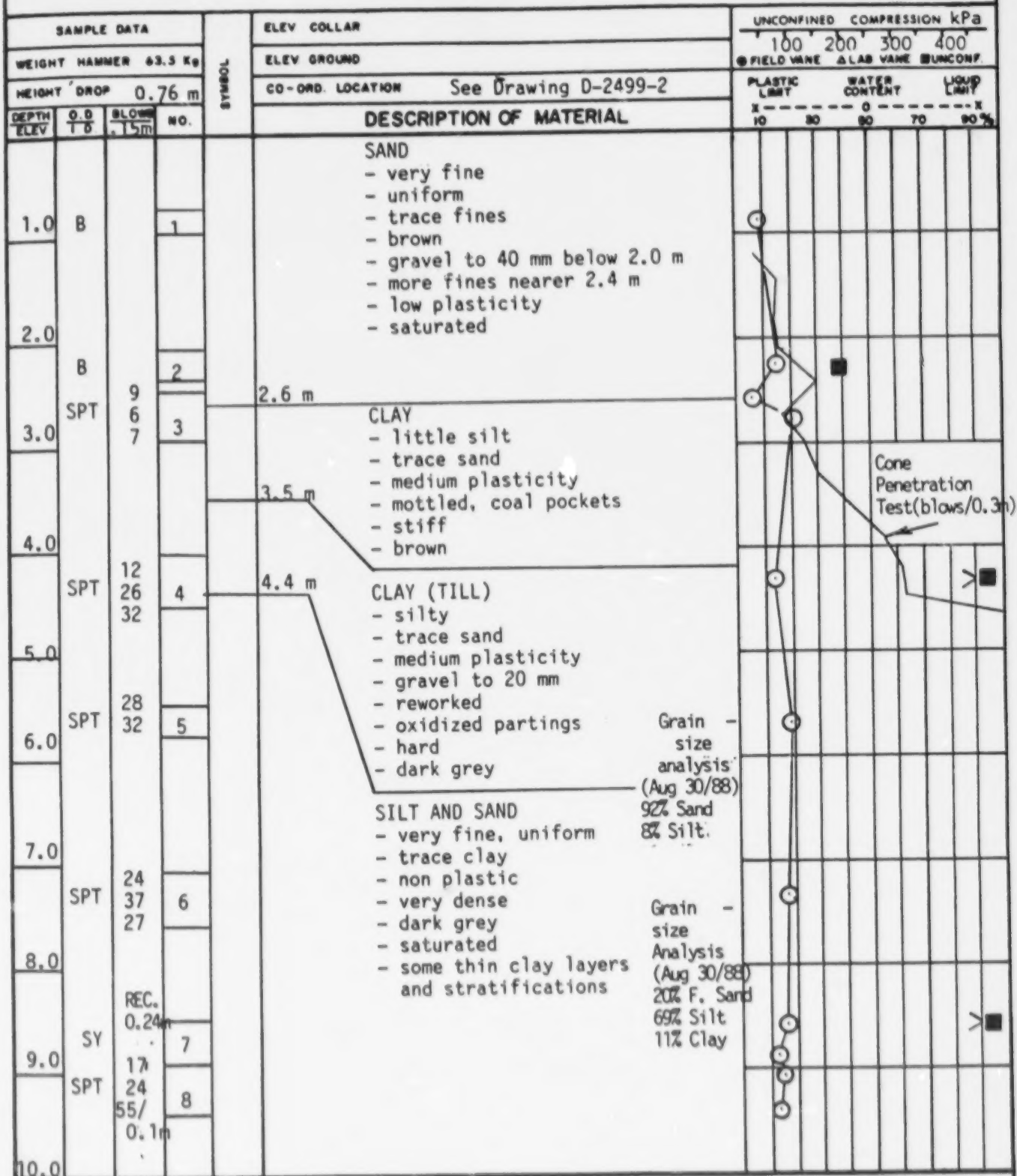
JOB No. PA 2499.02
PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. TH88-21
DATE AUG. 24 1988 PLATE

TEST HOLE LOG

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JOB No.	PA 2499.02
PROJECT	ALBERTA PROJECT
LOCATION	ATHABASCA AREA
HOLE No.	TH88-21
DATE	AUG 24, 1988
PLATE	

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JOB No. PA 2499.02

PROJECT ALBERTA PROJECT

LOCATION ATHABASCA AREA

HOLE No. TH88-22

DATE AUG. 25, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR		UNCONFINED COMPRESSION kPa							
WEIGHT HAMMER 63.5 kg					ELEV GROUND 579.2 m		100 200 300 400							
WEIGHT DROP 0.76 m					CO-ORD LOCATION		FIELD VALUE LAB VALUE UNCONF							
DEPTH ELEV	Q T ₈	BLOW 15m	NO.	DESCRIPTION OF MATERIAL		PLASTIC LIMIT	WATER CONTENT	LIQUID LIMIT						
						10	20	30	40	50	60	70	80	90
11.0	SPT	31	9	SAND, very fine, uniform		○								
		57		- as above										
12.0	SPT	100	10	SILTSONE (BEDROCK)		○								
		0.14		- dark grey - hard										
				11.6 m										
				11.7 m										
				END OF HOLE										
				NOTES:										
				1. Solid stem auger to 2.4 m; hollow stem to 11.7 m.										
				2. Auger/rig refusal at 11.7 m.										
				3. Sluff and water to 4.0 m after drilling.										
				4. Cone penetration test conducted (cone dia. 60 mm)										



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JOB No. PA 2499.02
PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. TH88-22
DATE AUG 25, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR	UNCONFINED COMPRESSION kPa			
WEIGHT HAMMER 63.5 kg					ELEV GROUND	100	200	300	400
HEIGHT DROP 0.76 m					CO-ORD LOCATION	● FIELD VANE	▲ LAB VANE	■ UNCONF	
DEPTH ELEV	Q 1/8	BLOW 1/5m	NO.		DESCRIPTION OF MATERIAL	PLASTIC LIMIT	WATER CONTENT	LIQUID LIMIT	
					X	0	X		
					10	30	70	80 %	
1.0	B	10	1	SAND, very fine, uniform - trace fines, rootlets - brown, loose density					
	SPT	7	2						
	B	6	3						
2.0									
3.0	SPT	4	4						
		5							
	B	8	5						
				3.4 m					
4.0	B		6	CLAY (TILL) - some silt - little sand - medium plasticity - trace gravel - slightly mottled - oxidized partings - dark grey - very stiff					
	SY	REC 0.21m	7	Grain size analysis (Aug 30/88) 13% Sand 43% Silt 44% Clay					
	SPT	8	8						
5.0		11							
		14							
6.0	SPT	8	9						
		18							
		21							
7.0	B		9A						
	SPT	9	10						
		16							
		26							
8.0									
9.0	SPT	17	11						
		60/							
		0.1 m							
10.0	B		12	SAND AND SILT - non plastic - saturated - gravel to 40 mm - grey, very dense					



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JOB No. PA 2499.02
PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. TH88-23
DATE AUG 23, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR	UNCONFINED COMPRESSION kPa					
WEIGHT HAMMER 63.5 Kg					ELEV GROUND 573.2 m	100	200	300	400		
HEIGHT DROP 0.76 m					CO-ORD. LOCATION	FIELD VANE LAB VANE UNCONF.					
DEPTH ELEV	O.D. T.D.	BLOW COUNT	NO.		DESCRIPTION OF MATERIAL	PLASTIC LIMIT	WATER CONTENT	LIQUID LIMIT			
				X		10	30	50	70	90	
11.0					SAND AND SILT - as above						
12.0	SPT	14 14 36	13		CLAY (TILL) - little silt - trace sand, well graded - medium plastic - trace gravel, mostly fine - dark grey - hard					> ■	
13.0											
14.0											
15.0	SPT	14 23 38	14								> ■
16.0											
17.0											
18.0	SPT	13 23 35	15		- oxidized spots					> ■	
19.0											
20.0											



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JOB No. PA 2499.02
PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. TH88-23
DATE AUG 23, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR		UNCONFINED COMPRESSION kPa					
WEIGHT HAMMER 63.5 Kg					ELEV GROUND 573.2 m		100 200 300 400					
WEIGHT DROP 0.76 m					CO-ORD. LOCATION		● FIELD VANE ▲ LAB VANE ■ UNCONF.					
DEPTH ELEV	O.D. T.D.	BLOW COUNT	NO.		DESCRIPTION OF MATERIAL		PLASTIC LIMIT	WATER CONTENT	LIQUID LIMIT			
X	10	30	50	70	90	X	10	30	50	70	90	X
21.0	SPT	12	16	21.2 m	CLAY (TILL) - as above - gravel to 20 mm							
22.0		27			END OF HOLE							
23.0		40			NOTES: 1. Solid stem auger to 10.1 m; hollow stem to 21.2 m.							
24.0					2. End of hole in clay till at 21.2 m.							
25.0					3. Sluff to 19.5 m, water to 10.1 m after drilling.							
26.0												
27.0												
28.0												
29.0												
30.0												



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JOB No. PA 2499.02
PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. TH88-23
DATE AUG 23, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR		UNCONFINED COMPRESSION kPa				
WEIGHT HAMMER 63.5 kg					ELEV. GROUND		100 200 300 400				
HEIGHT DROP 0.76 m					CO-ORD. LOCATION See Drawing D-2499-2		● FIELD VANE ▲ LAB VANE ■ UNCONF.				
DEPTH ELEV	O.D. I.D.	BLOW COUNT	NO.		DESCRIPTION OF MATERIAL		PLASTIC LIMIT	WATER CONTENT	LIQUID LIMIT		
						X 10	30	60	70	90 %	
1.0	B		1	CLAY - silty - little sand - low plasticity - gravel to 30 mm - oxidized spots - brown - saturated nearer 4.0 m - stiff							
2.0	B		2								
3.0	SY	7	3		- crimped tube						
3.0	SPT	14	4		- saturated sand seams						
4.0	B		5								
4.0				4.0 m							
5.0	SPT	6 10 14	6	CLAY (TILL) - little silt - trace sand - medium to high plasticity - occasional gravel sizes - oxidized partings - dark grey - hard - saturated sand seam at 6.1 m very dense						> ■	
6.0	SY	REC. 0.25m	7		- poor sample						■
6.0	SPT	13 20 16	8								> ■
7.0	SPT	20/ 0.3m 20/ 0.15m	9								> ■
8.0	SPT										
9.0	SPT	6 14 24	10	NOTES: 1. Solid stem auger to 4.0 m; hollow stem to 30.3 m. 2. Out of auger at 30.3 m. 3. Sluff to 28.3 m after drilling.						> ■	
10.0											



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JOB No. PA 2499.02
PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. TH88-24
DATE AUG. 23, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR	UNCONFINED COMPRESSION kPa				
WEIGHT HAMMER 63.5 kg					ELEV GROUND 576.8 m	100	200	300	400	
HEIGHT DROP 0.76 m					CO-ORD. LOCATION	FIELD VANE	LAB VANE	UNCONF		
DEPTH ELEV	O.D. T.D.	BLOW COUNT	NO.		DESCRIPTION OF MATERIAL	PLASTIC LIMIT	WATER CONTENT	LIQUID LIMIT		
					X	10	30	0	70	90
11.0	SPT	5 12 22	11	CLAY (TILL) - little silt - trace sand - medium to high plasticity - occasional gravel sizes - dark grey - hard	○					> ■
12.0	SPT	14 21 35	12		○					> ■
13.0				- harder drilling						
14.0										
15.0	SPT	9 20 30	13		○					> ■
16.0										
17.0										
18.0	SPT	14 18 32	14	- very fine, dense, saturated sand layer at 17.7 m	○					■ >
19.0					○					> ■
20.0										



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JOB No. PA 2499.02
PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. TH88-24
DATE AUG 23, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR	UNCONFINED COMPRESSION kPa			
WEIGHT HAMMER 63.5 Kg					ELEV GROUND 576.8 m	100	200	300	400
HEIGHT DROP 0.76 m					CO-ORD. LOCATION	FIELD VANE LAB VANE UNCONF.			
DEPTH ELEV	O.B. T.B.	BLOW 15m	NO.		DESCRIPTION OF MATERIAL	PLASTIC LIMIT	WATER CONTENT	LIQUID LIMIT	
					X-----X				
					10 30 50 70 90 %				
21.0	SPT	11 20 36	15	- smooth but hard drilling				>■	
22.0									
23.0				CLAY (LACUSTRINE) - silty - trace sand - high plasticity - dark grey - hard					
24.0	SPT	15 25 46	16	HYDROMETER/SIEVE ANALYSIS (AUG 30, 1988): 13% Sand 47% Silt 40% Clay	○	---	×	>■	
25.0									
26.0				- harder drilling; advance difficult					
27.0	SPT	14 28 55	17	CLAY (TILL)				>■	
28.0									
29.0				CLAY (LACUSTRINE)					
30.0	SPT	11 16 27	18	END OF HOLE AT 30.3 m				>■	



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JOB No. PA 2499.02
PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. 1H88-24
DATE AUG 23, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR		UNCONFINED COMPRESSION kPa			
WEIGHT HAMMER 43.5 Kg					ELEV GROUND 578.6 m		100 200 300 400			
HEIGHT DROP 0.76 m					CO-ORD. LOCATION See Drawing D-2499-2		FIELD VANE LAB VANE UNCONF			
DEPTH ELEV	O.D. T.B.	BLOW 1.5m	NO.		DESCRIPTION OF MATERIAL		PLASTIC LIMIT	WATER CONTENT	LIQUID LIMIT	
						X 10	30 60 70 90 %	X		
1.0	B		1		GRAVEL AND SAND (ROAD BED) - clay, (fill), sandy, brown					
					1.2 m					
	B		2A		1.4 m SAND, trace fines, loose, brown					
	B		2							
2.0					SAND AND GRAVEL - little silt - medium plasticity - gravel to 30 mm - mottled, thin organic laminations					
	SY	NO REC.	3		crimped tube					
3.0	SPT	10	4		Grain Size Analysis: 3% Gravel 53% Sand 27% Silt 17% Clay					
	B	19	5							
4.0										
	SY	6	6		CLAY (TILL) - trace silt - trace sand - medium plasticity - gravel to 50 mm, occasional cobble sizes - dark grey - hard					
	SPT	11	7							
5.0		13								
	SPT	6	8							
6.0		12								
	SPT	19								
7.0										
	SY	NO REC.	9		Crimped tube					
	SPT	14	10		- split spoon damaged beyond repair - hit cobble					
8.0		22								
9.0										
10.0										



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JOB No. PA 2499.02

PROJECT ALBERTA PROJECT

LOCATION ATHABASCA AREA

HOLE No. TH88-25

DATE AUG 24, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR		UNCONFINED COMPRESSION kPa																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
WEIGHT HAMMER 63.5 Kg					ELEV GROUND 578.6 m		100 200 300 400																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
HEIGHT DROP 0.76 m					CO-ORD. LOCATION		● FIELD VANE ▲ LAB VANE ■ UNCONF.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
DESCRIPTION OF MATERIAL					PLASTIC LIMIT WATER CONTENT LIQUID LIMIT																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
DEPTH ELEV	O.D. I.D.	BLOW COUNT	NO.					X	0	X																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
		REC. 15m						10	20	30 40 50 60 70 80 90 100																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
11.0	SY SPT	0.18m	11		- fair sample	CLAY (TILL) - as above																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								



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JOB No. PA 2499.02
PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. TH88-25
DATE AUG 24, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR	UNCONFINED COMPRESSION kPa					
WEIGHT HAMMER 63.5 Kg					ELEV GROUND 578.6 m	100 200 300 400 ● FIELD VANE ▲ LAB VANE ■ UNCONF.					
HEIGHT DROP 0.76 m					CO-ORD. LOCATION	PLASTIC LIQ. WATER CONTENT					
DEPTH ELEV	O.D. I.D.	BLOW COUNT	NO.		DESCRIPTION OF MATERIAL	10	30	60	70	80 %	
21.0		22		SILT AND SAND - as above							
		27	16		21.0 m						>■
22.0		27		CLAY (LACUSTRINE) - little silt - trace sand, very fine - high plasticity - laminated - grey - hard						>■	
23.0											
24.0		13	17		- no recovery						
		22			- very hard drilling						
25.0		34									
				- fine sand pockets							
26.0		19	18								>■
		23									
		39									
27.0											
				SILTSTONE (BEDROCK)							
				- sandy							
28.0				- trace clay							
				- non plastic							
				- rig lifting							
				- very dense							
				END OF HOLE							
28.4		100/0.1m	19								
29.0				NOTES:							
				1. Solid stem auger to 4.0 m;							
				hollow stem to 28.4 m.							
				2. Rig refusal at 28.4 m.							
				3. Sluff to 11.3 m after drilling.							
				4. Cone penetration test							
				conducted (cone dia. 60 mm).							
30.0											



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JOB No. PA 2499.02
PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. TH88-25
DATE AUG 24, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				TORSAS	ELEV COLLAR		UNCONFINED COMPRESSION kPa			
WEIGHT HAMMER 63.5 Kg					ELEV GROUND 579.5 m		100 200 300 400			
HEIGHT DROP 0.76 m					CO-ORD. LOCATION See Drawing D-2499-2		FIELD VANE LAB VANE UNCONF			
DEPTH ELEV	O.D. I.D.	BLOW 15m	NO.		DESCRIPTION OF MATERIAL		PLASTIC LIMIT	WATER CONTENT	LIQUID LIMIT	
						X	0	X		
						10	80	80		
						70	90	90		
1.0					GRAVEL AND SAND					
					- clayey					
					- silty					
					- layers of gravel to 5mm					
					(sluffing into hole)					
2.0	SPT	10 23 35	1		- no recovery					
3.0										
4.0	SPT	7 5 5	2		- no recovery					
5.0	SY	NO REC.	3		5.0 m					
6.0	SPT	50 bouncing	4		SILT AND SAND					
					- very fine					
					- uniform					
					- non plastic					
					- trace to little clay					
					- dark grey					
					- very dense					
					- saturated					
8.0	SPT	45 50/ 115 mm	5		- limit results: non plastic					
					(Aug 30, 1988)					
					- Grain size analysis (Aug 30/88)					
					32% Sand, Fine					
					57% Silt					
					11% Clay					
10.0	SPT	60 45/ 100mm	6							



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JOB No. PA 2499.02
PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. TH88-26
DATE AUG 18, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR		UNCONFINED COMPRESSION kPa				
WEIGHT HAMMER 63.5 Kg					ELEV GROUND 579.5 m		100 200 300 400				
WEIGHT DROP 0.76 m					CO-ORD. LOCATION		● FIELD VANE ▲ LAB VANE ■ UNCONF				
DEPTH ELEV	O.D. I.D.	BLOW COUNT	NO.		DESCRIPTION OF MATERIAL		PLASTIC LIMIT	WATER CONTENT	LIQUID LIMIT		
						X	10	30	60	70	90
11.0					SAND - as above - drill clatter at 10.1 m (gravel?)						
12.0					CLAY (TILL) - some silt - little sand - medium plastic - trace gravel - pockets and layers of fine sand - dark grey - very stiff to hard						
13.0		50 54/ 25mm	7		- drill clatter at 13.1 m						
14.0											
15.0											
16.0		25 56 25/ 50mm	8		- advancing difficult						
17.0		23 32 45	9		- shelby sample not suitable for testing						
18.0			10		END OF HOLE						
					NOTES: 1. End of hole in clay till at 17.5 m						
					2. Wet rotary drill used.						



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JOB No. PA 2499.02
PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. TH88-26
DATE AUG 18, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR		UNCONFINED COMPRESSION kPa			
WEIGHT HAMMER 63.5 Kg					ELEV GROUND 570.8 m		100 200 300 400			
WEIGHT DROP 0.76 m					CO-ORD. LOCATION See Drawing D-2499-2		● FIELD VANE ▲ LAB VANE ■ UNCONF.			
DEPTH ELEV	O.D. I.D.	BLOW COUNT	NO.		DESCRIPTION OF MATERIAL		PLASTIC LIMIT X	WATER CONTENT O	LIQUID LIMIT X	
						10	30	60	70	90
1.0					SAND					
					- fine and uniform					
					- some gravel sizes					
					- trace fines					
					- organic specs					
					- rusty brown					
2.0	SY		1	1.8 m						
	SPT	4	2		SAND AND GRAVEL					
		5			- some fines					
		7			- low plasticity					
3.0					- mottled					
	SPT	16	3	3.7 m	- brown					
		21			- saturated					
4.0		14/			- penetrometer hit rock at 3.4 m					
		65 mm								
5.0					CLAY (TILL)					
					- little silt					
					- trace sand					
					- medium plasticity					
					- trace gravel					
					- dark grey					
					- very stiff to hard					
6.0										
	SPT	22	4							
		11								
7.0		17								
8.0	SY	NO REC	5		crimped					
	SPT	14	6		tube					
		22			no					
		42			recovery					
9.0										
	SPT	15	7							
		25								
		37								
10.0										



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JOB No. PA 2499.02
PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. TH88-27
DATE AUG 17, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR		UNCONFINED COMPRESSION kPa				
WEIGHT HAMMER 63.5 Kg					ELEV GROUND 570.8 m		100 200 300 400				
HEIGHT DROP 0.76 m					CO-ORD. LOCATION		FIELD VANE LAB VANE UNCONF				
DEPTH ELEV	O.D. I.D.	BLOW COUNT	NO.		DESCRIPTION OF MATERIAL		PLASTIC LIMIT		WATER CONTENT		LIQUID LIMIT
						X --- X		O --- O		X --- X	
						10 30 50 70 90 %		10 30 50 70 90 %		10 30 50 70 90 %	
11.0					CLAY (TILL)						
					- little silt						
					- trace sand						
					- medium plasticity						
					- trace gravel						
					- dark grey						
					- hard						
12.0											
		15									
		30									
	SPT	47	8		- no recovery						
					- cuttings indicate CLAY (TILL)						
13.0											
14.0											
					13.9 m						
15.0					CLAY (LACUSTRINE)						
					- little silt						
					- trace very fine sand						
					- high plasticity						
					- laminated						
					- dark grey						
					- hard						
16.0		23									
	SPT	25	9								
		37									
					- hard drilling at 16.2 m						
17.0											
18.0											
19.0		19									
	SPT	28	10								
		45			18.7 m						
20.0					CLAYSTONE (BEDROCK)						
					- trace silt, trace fine sand						
					- high plasticity						
					- laminated						
					- dark grey, hard						



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JOB No. PA 2499.02
PROJECT ALBERTA PROJECT
LOCATION ATHABASCA AREA
HOLE No. TH88-27
DATE AUG 17, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR		UNCONFINED COMPRESSION kPa					
WEIGHT HAMMER 63.5 Kg					ELEV GROUND 570.8 m		100 200 300 400					
HEIGHT DROP 0.76 m					CO-ORD. LOCATION		FIELD VANE LAB VANE UNCONF.					
DEPTH ELEV	O.D. I.D.	BLOW 15m	NO.	DESCRIPTION OF MATERIAL		PLASTIC LIMIT		WATER CONTENT		LIQUID LIMIT		
X	10	20	30	40	50	60	70	80	90	100	%	
21.0				SPT	29 50 65	11	CLAYSTONE (BEDROCK) - trace silt - trace fine sand - high plastic - laminated - dark grey - hard	C			>■	
22.0												
23.0												
24.0				SPT	47 50/ 100mm	12	24.7 m	C			>■	
25.0												
					END OF HOLE							
					NOTES:		1. End of hole in claystone bedrock at 24.7 m.					
							2. Wet rotary drill used.					



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JOB No. PA 2499.02

PROJECT ALBERTA PROJECT

LOCATION ATHABASCA AREA

HOLE No. TH88-27

DATE AUG 17, 1988 PLATE



TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR		UNCONFINED COMPRESSION kPa			
WEIGHT HAMMER 63.5 Kg					ELEV GROUND 566.0 m		100 200 300 400			
HEIGHT DROP 0.76 m					CO-ORD LOCATION See Drawing D-2499-2		FIELD VANE LAB VANE UNCONF			
DEPTH	O.D	BLOW	NO.		DESCRIPTION OF MATERIAL		PLASTIC	WATER	LIQUID	
ELEV	I.D	15m				LIMIT	CONTENT	LIMIT		
						X	0	X		
						10	30	50		
1.0				CLAY - trace silt - some sand - medium to high plasticity - rootlets - fine sand parting - grey-brown, stiff - saturated - trace gravel turning gravelly nearer 3.7 m - tried shelby at 3.0 m, crimped end						
2.0	SPT	3	1							
		4								
3.0				3.7 m						
	B		2							
4.0										
5.0	SY	REC IN BAG	3	SAND - poorly graded - medium to fine gradation - trace fines - brown - saturated - very dense						
	SPT	21	4							
		36								
6.0				7.3 m						
7.0										
8.0	SPT	22	5	CLAY (TILL) - little silt - trace sand - medium plasticity, hard - trace gravel - dark grey turning brown below approx. 9.0 m - saturated uniform fine sand layer at 7.8 m, very dense						
		48								
		30/75mm								
9.0										
10.0										



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JOB No. PA 2499.02.

PROJECT ALBERTA PROJECT

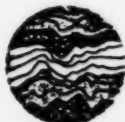
LOCATION ATHABASCA AREA

HOLE No. TH88-28

DATE AUG 18, 1963 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR	UNCONFINED COMPRESSION kPa			
WEIGHT HAMMER 63.5 Kg					ELEV GROUND 566.0 m	100	200	300	400
HEIGHT DROP 0.76 m					CO-ORD. LOCATION	● FIELD VANE	Δ LAB VANE	■ UNCONF	
DEPTH ELEV	O.D. I.D.	BLOWN 15m	NO.		DESCRIPTION OF MATERIAL	PLASTIC LIMIT	WATER CONTENT	LIQUID LIMIT	
					X	0	X		
					10	30	70	90%	
11.0				CLAY (TILL) - little silt - trace sand - medium plasticity - trace gravel, possible cobbles - brown, hard - saturated near sand layer					
12.0									
13.0									
13.0				- cobble/boulder (?) protruding into hole					
				13.7 m					
14.0				CLAYSTONE (BEDROCK) - high plasticity - laminated, slickensides - dark grey - hard					
15.0									
16.0									
16.0									
17.0									
18.0									
18.0									
19.0				18.5 m					
				END OF HOLE					
19.0				NOTES: 1. End of hole in bedrock at 18.5 m. 2. Wet rotary drill used.					
20.0									



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JOB No.	PA 2499.02
PROJECT	ALBERTA PROJECT
LOCATION	ATHABASCA AREA
HOLE No.	TH88-28
DATE	AUG 18, 1988 PLATE

TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR	UNCONFINED COMPRESSION kPa			
WEIGHT HAMMER 63.5 Kg					ELEV GROUND 577.8 m	100	200	300	400
HEIGHT DROP 0.76 m					CO-ORD LOCATION See Drawing D-2499-2	● FIELD VANE	△ LAB VANE	■ UNCONF	
DEPTH ELEV	O.D. T.D.	BLOW COUNT	NO.		DESCRIPTION OF MATERIAL	PLASTIC LIMIT X	WATER CONTENT 0	LIQUID LIMIT X	
1.0				SAND - fairly well graded - trace fines - gravelly - brown (oxidized) - clay lumps, mottled, brown - low plasticity - medium dense to very dense					
2.0		8 9 13	1						
3.0									
4.0		16 19 26	2						
5.0									
				- saturated sand layer at 4.5 m					
6.0		14 19 29	3	5.2 m					
7.0				CLAY (TILL) - silty - little sand - low plasticity - trace gravel - dark grey - very stiff to hard					
8.0		13 20 32	4						
9.0				SILT AND SAND, VERY FINE - trace clay - non plastic - dark grey - very dense, hard - saturated - laminated					
10.0									
		30 40 45	5						



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HOLE No. TH88-29
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TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV COLLAR		UNCONFINED COMPRESSION kPa			
WEIGHT HAMMER 63.5 Kg					ELEV GROUND 577.8 m		100 200 300 400			
HEIGHT DROP 0.76 m					CO-ORD. LOCATION		● FIELD VANE ▲ LAB VANE ■ UNCONF			
DEPTH ELEV	O.D. I.D.	BLOW 15m	NO.		DESCRIPTION OF MATERIAL		PLASTIC LIMIT	WATER CONTENT	LIQUID LIMIT	
X						X		X		
10						10	30	60	70	
11.0					SILT AND SAND - as above					
					11.3 m					
12.0					CLAY (TILL) - some silt - little sand - low plasticity - gravelly - dark grey - hard					
		25								
		47	6							
13.0		50								
14.0										
15.0										
		68			NOTES: 1. End of hole in clay till at 18.7 m					
		38/	7		2. Wet rotary drill used.					
16.0		75mm								
17.0										
18.0										
19.0		25			18.7 m					
		40	8							
		35/								
20.0		100mm			END OF HOLE					



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